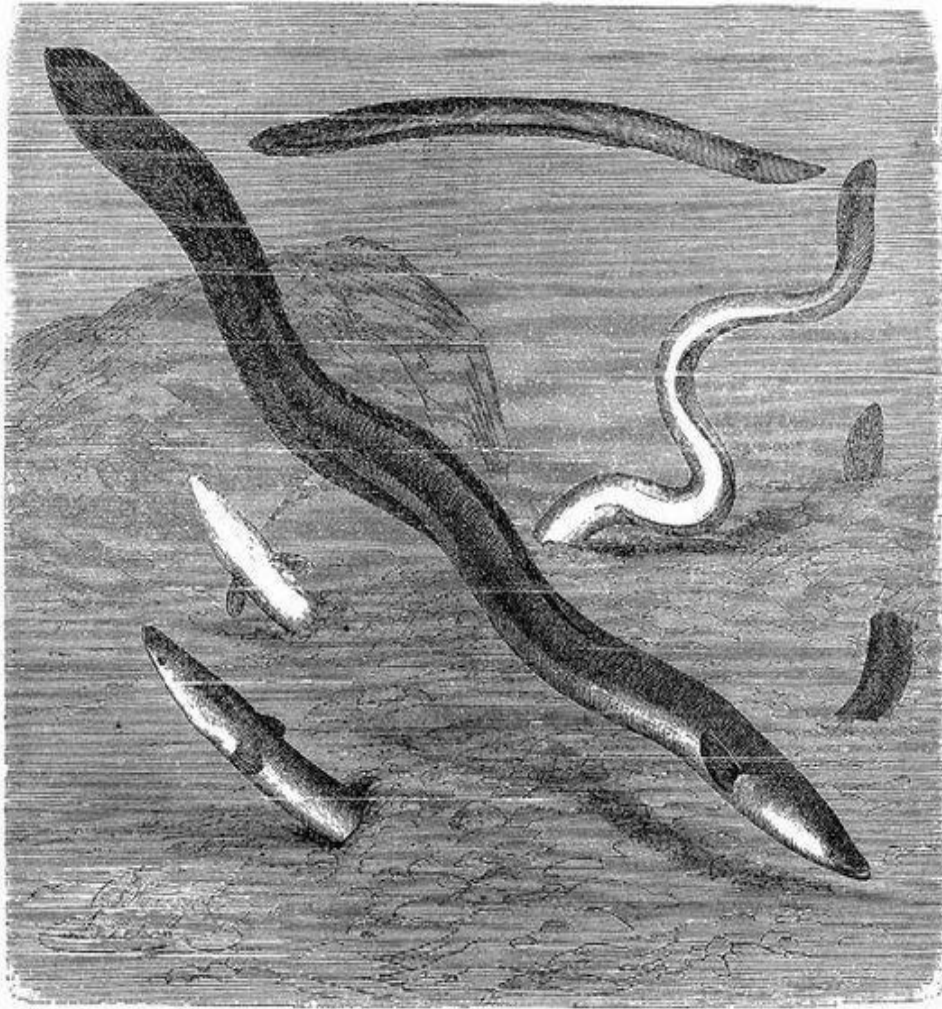


# EEL RANGER PROGRAMME



**Investigate a future where fishermen become Eel Rangers**

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## 1. Executive Summary

The migratory European eel (*Anguilla anguilla*) is currently listed as critically endangered on the IUCN Red List. The eel stock is declining, including across the Netherlands. This is due to many threats, such as barriers, low water quality, habitat loss, global warming and over-exploitation, all of which act synergistically. There are efforts in place by the national government to tackle some of these issues, though many of these solutions will take quite some time (i.e., adjusting dykes and dams). For this project, the focus is placed on the threat of eel fishing, particularly legal small-scale fishing.

While large scale eel 'farming' is practiced in the Netherlands, the focus lies on traditional eel fishing (also known as 'wild eel fishing'). This is a practice that has taken place in Dutch waters since feudal times and it is also paired with a strong culture of eating smoked eel. Increased regulations and total bans in some European nations put this traditional way of fishing at risk of disappearing. The Netherlands currently has a three-month ban in place, but until now there are no signs the stock is recovering. These effects will not be seen for another generation as the life cycle of eels are long and they can only reproduce once. This makes eel conservation efforts particularly challenging.

Good Fish is dedicated to saving the eel whilst also trying to avoid a complete ban on wild eel fishing and therefore have commissioned this research. The aim of this project is to make an economic plan, describing alternatives for eel fishers in their transition as "eel rangers" in the Netherlands. The reasoning behind this effort is to find ways that fishers can use their traditional knowledge of eels and waterways in order to help the conservation of eels whilst maintaining their livelihood. This research was carried out by completing a literature study as well as 13 interviews from four different groups of stakeholders: academics, NGOs, fishermen and waterboards. These interviews were all coded using inductive and deductive coding on Atlas.ti software. Data was also collected on the financial responsibilities of the different ranger jobs and possible costs were described.

Five possible ranger opportunities were found through the data analysis: assisting in research, moving the eel over barriers, fishing for alternative species instead of eel, anti-poaching efforts and finally, an array of non-fishing job alternatives. Each of these alternatives is discussed using the primary data as well as published literature, including fish management case studies from different countries. Assisting in research was the most mentioned option, in part due to the fact some fishers are already involved in research for consultancies, NGOs, waterboards and academics. This option seems the most likely to take place as the critical state of the eel requires frequent monitoring. Fishers are also already involved in moving eels over barriers such as in DUPAN (Duurzame Palingsector Nederland) "Eels over the Dykes" project, but this could be an effort that is expanded with more fishers. There is, however, a significant debate surrounding the efficiency of this technique in helping the eel population recover, reflected in both the literature and the interview responses. Fishing for alternative species, particularly invasive species, is also examined. Some species are already fished on, making this easier to expand and therefore a strong possibility. However, their markets should be comparable in extent to that of the eel, for this shift to be possible. These requirements are harder to meet, especially in the shortterm. Anti-poaching is an option with mixed impressions across interviewees, this option makes sense as fishers are already on the waters and can use their knowledge to note illegal fishing. However, the social implications of having anti-poaching rangers are often very complex. Finally, the non-fishing job alternatives derived largely from a water board which already employs an 'ex-eel fisher' to do them, instead of fishing. These activities include monitoring water quality or weeding habitats and were already part of the regular tasks of the waterboard.

For each of these possible ranger jobs, participants had different ideas of who was responsible for funding the salaries and extra costs these activities require for fishers to do them. The four main groups

that were identified were academia (specifically universities), the Dutch government (this includes the Ministry of Agriculture, Nature and Food quality (LNV) and regional waterboards), NGOs (such as WWF but also the National Postcode Lottery) and the European Union. Largely, the responsibility of funding was placed on the Dutch government, both the LNV and waterboards. In order to better understand what this funding might look like, estimates of the gross salary of fishers were made based on secondary data. First, the number of eel fishers in the country was estimated at 80 fishers, based on our interview data. The salary of a single fisher will depend on multiple factors, the amount of eel they catch per year, the quality of eel they catch (yellow or silver) the price of the eel that year (including fluctuations throughout the year) and the operational costs they have. The range of gross salary found was between €39,325 and €66,550, depending on eel prices and assuming the total catch of wild eels is evenly divided between the 80 fishers. Finding the precise salary of fishers is only possible by discussing this with the individual fishers as they will all fish different quantities depending on their boat size and frequency of fishing. The salary for these alternative jobs ought to at least match the salary that fishers are currently paid when they participate in research with RAVON, which is €50 per hour. Though further research is needed concerning the costs and salaries for these jobs.

Some other key findings in this research were reoccurring topics that suggested a transition to eel rangers would have more challenges than just the funding. The major challenge that was found was the apparent lack of trust between the different stakeholders. This lack of trust between fishers and the government as well as science in general, presents a large challenge. Eel fishers are unlikely to switch away from eel fishing if they do not believe eel populations are decreasing. The tradition and culture surrounding eel fishing is also a significant finding as it may present a significant barrier to overcome when discussing reducing eel fishing, as some people may interpret efforts to reduce eel fishing as an attack on Dutch culture.

In conclusion, this report suggests different jobs of what an eel ranger programme might look like in order to sustain the livelihood of fishers whilst also involving them in eel conservation efforts. Certain jobs are more likely to be well-accepted by fishers as some are already practiced, whilst others may require more new changes (anti-poaching). The most significant conclusion is that fishers are a very heterogenous group and the willingness to be involved in a programme such as this will be dependent on each individual. The same can be said of their eel fishing-based salaries, which would have to be met by these alternative jobs.

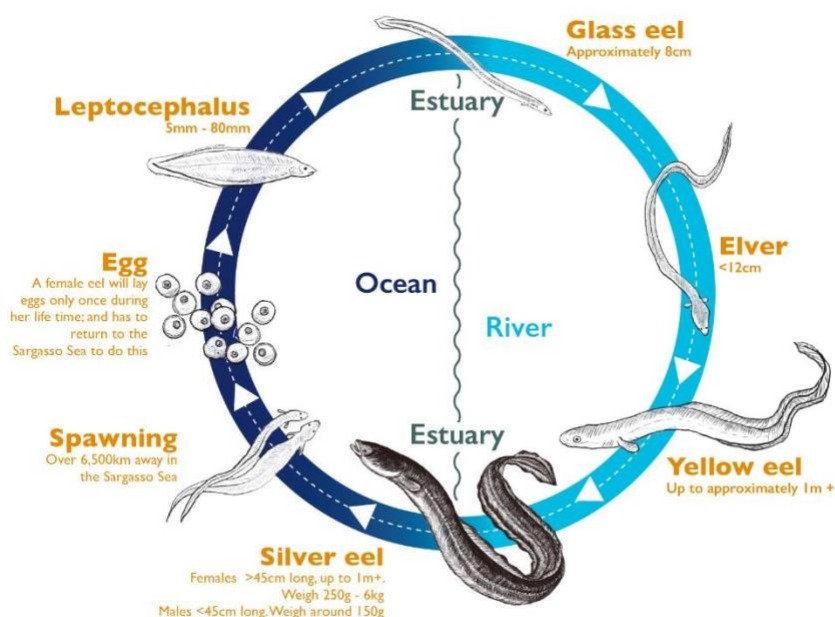


Figure 1: Life cycle of the eel

### 1.1 Current status

Numerous scientific studies indicate that European eel stock is declining in Europe and the population has been in critical condition for the recent decades (Knights, 2006; Bark et al., 2007; Bevacqua et al., 2015), being listed as “critically endangered” by IUCN (2020). In 2021, the International Council for the Exploration of the Sea (ICES) advised all member states on zero catch for eel for both commercial and recreational fisheries. (ICES, 2021). Despite restoration efforts and regulations by multiple instances (European Commission, NGOs), the stock has not recovered noticeably due to cumulative effects of various threats. The most important threats being global warming, water pollution & toxicity, habitat loss, migration barriers, parasite infections and overexploitation (both legal and illegal) (Feunsteun et al., 2002; Drouineau et al., 2018). Restoration efforts for this species are difficult to ascertain considering its long-life cycle with significant changes only noticeable in the long term.

### 1.2 Current situation in conservation EU & NL

In 2007, the EU created a management framework for the recovery of the European eel (known as “Eel regulation”). Subsequently, member states developed and adopted, “Eel Management Plans” (EMP), in their river basins, in which the silver eel escapement should return to 40% of the reference level in 1980. Additionally, the restocking of glass eels should take place in inland waters (EC Regulation No. 1100/2007; EC, 2007). Various reports (“Progress Reports”) have been made by member states to track changes in the populations, but research showed no major improvements and so, in 2018, member states agreed upon a Joint Declaration (Council Regulation EU 2018/120), consisting of a consecutive three-month closure on all eel fishing (commercial and recreational), regardless of life stage, with the purpose of protecting eels during their annual migration. Additionally, under this declaration, the EU agreed to review eel restocking plans and combat poaching in EU waters and the Baltic Sea. EMPs must draw reports every three years on how each member state implemented its measures through reducing commercial and recreational fishing, restocking measures, improving fish barriers and eel habitat along with other indicators. The majority of the measures taken by the EU and subsequent implementation have focused on fisheries, as other measures are considered more expensive and challenging (European Commission et al., 2020).

The Ministry of Agriculture, Nature and Food Quality (LNV) is responsible to execute the EMP in the Netherlands, according to EU decree. Even before the EU decision, the country had already set a threemonth closure for eel fisheries. This closure takes place between the 1st of September and the 1st of December for all water bodies (FishSec, 2021). The exception being Friesland which has a maximum quota of 36.6 tonnes per year which started as a pilot project in 2011 (Prins & Zaalmink, 2015). Eel management is consequently very difficult to handle at the local, regional, national, and international levels, due to the migratory nature of this species. Improved inter-stakeholder coordination is required for effective species management and protection.

### 1.3 Culture and tradition of eel fishing

Eel fishing started as a traditional practice in the Netherlands, with families that go hundreds of years back in mastering this craft. It is reported that already in feudal times, eel fishing was the exclusive right of feudal lords, picturing how crucial this practice has been in Dutch history (Heinsbroek, 1991). Considering that eel fishing has records that date back hundreds of years, it can be considered both a

tradition and cultural activity. It should also be mentioned that the eel fishing culture comes with a significant culture of consuming eel, especially smoked (van den Thillart, 2014).

Further, we believe this practice fits the definition of traditional ecological knowledge. Berkes (2012) defines Traditional Ecological Knowledge (TEK) as “a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment”. Following this definition, paired with the rich history of eel fishing, it can be argued that this practice merits to be appreciated and maintained as Dutch TEK. Lloret et al., (2018) argue that a loss of fisher’s knowledge is not only a loss of socio-cultural value but of ecological knowledge of complex systems and biodiversity. There are then two arguments to be made, the first is that the sociocultural value of traditional fishers in the Netherlands deserves to be retained and continued in matters of intangible cultural patrimony. Secondly, in the case of the eel, the existing knowledge that fishers have can be used to improve existing conservation efforts by involving them in research (Haggan et al., 2007). Considering the grave state of the eel population, the latter is not a notion to take lightly.

#### 1.4 The eel industry sector

Eel fishing has expanded since feudal times and is being done on a bigger scale in current times, including large scale nurseries of glass eel. Traditional eel fishers work either on open waters or in rivers. Here they use traps (fyke nets), which they generally attach to each other to create a long line that can reach an >100m and these are kept in place by anchors. They do not put these in the middle of the river as they might be destroyed by passing ships. The aquaculture sector of eel became more popular around 40 years ago. On these ‘eel farms’, they used water circulations systems to minimize losing heat, keep a consistent water condition and maximize the number of eel to grow. As a result, less labour was needed and they could culture eel in smaller water tanks.

The glass eel is collected from the channels of France (van der Hammen, 2018) and brought to the ‘eel farms’, where they are grown until they reach the desired weight. This could take between 1-3 years after which they refrain from eating and go into their final phase. They are sold before they become silver eels to maximize production (van den Thillart, 2014). Currently, the eel aquaculture sector is a much larger player in the eel industry than the inland eel fisheries. In 2020, for instance, approximately 475 tonnes of eel were caught in the wild, against around 2065 tonnes of eel that were produced in nurseries (Bryhn et al. 2021). The revenue of the aquaculture sector in the Netherlands was € 17,300,000 for 2035 tonnes in 2020 (NeVeVi, 2021). This large-scale eel ‘farming’ is seen as a threat to the eel, because it uses large amounts of glass eel caught in the wild as a base (van Walraven, 2016). Eel farmers gain significant amounts of revenue from the eel industry continuing; for this to change there are many social, economic and political aspects to consider. Moreover, the illegal trade of glass eels brings in significant amounts of profit to the black market, with estimates of approximately €3 billion every year (Sustainable Eel Group, 2019; Europol, 2021). Though aquaculture and illegal eel fishing play significant roles in the status of the eel, for the purpose of this report, we will only focus on what is termed ‘traditional eel fishing’ or ‘wild eel fishing’ and how this group could move more toward conservation of the eel.

#### 1.5 Knowledge gaps, motivation and intention

The aim of this project is to make an economic plan describing alternatives for eel fishers in their transition as “eel rangers” in the Netherlands and who is responsible for funding this. The eel ranger programme can be a contributing factor for the recovery of wild eel populations while maintaining traditional knowledge and know-how of fishers. While participation of fishers in conservation is not a novel idea (Granek et al., 2008), this social group represents a unique opportunity to provide an



opportunity for resource co-management (Campbell et al., 2009). Since 2015, ICES has advised all human impacts on silver eel to be kept as close to/or at zero (ICES, 2017; ICES, 2018; ICES, 2019; ICES, 2020) and in 2021 this was changed to “zero catches in all habitats” (ICES, 2021), including catches for restocking and aquaculture purposes. Thus, since eel populations have been considered under biological limits, a nation-wide ban on eel in the Netherlands is more likely to take place in the upcoming years. Therefore, it becomes urgent to consider the implications for the livelihoods of fishers. However, data on how to make this transition effective and economically feasible is lacking. Through this research, we strive to bridge this knowledge gap on financial responsibility and requirements.

## 2. Research Questions

Main research question:

- What economic requirements must be met for eel fishers to engage in a new eel ranger programme?

Sub questions:

- What tasks can the eel rangers perform in the eel ranger programme?
- What groups are responsible, or believed to be responsible, for financing the ranger programme?
- What funds are necessary to make this transition economically feasible?

The first sub-question had to be fully answered before the following two sub-questions could be answered. This is because it is impossible to know who is responsible for funding a programme nor how much this would cost without first understanding what this programme entails.

By answering the sub questions, we aim to find multiple different alternatives of livelihood for the fishers, ideally, ones that would also help the conservation of eels. Depending on the different jobs, different groups and organisations would be expected to finance the transition. For example, a task that involves collecting data on eels to inform national policy, can be expected to be funded by the national government. This expectation may lie in the actual legal responsibility of one party, but it could also be a responsibility that certain groups have assigned to this party, despite having no legal obligation to complete it. Finally, we aim to find realistic cost estimates for eel fishers to transition into alternative jobs.

## 3. Methods and limitations

### 3.1 Methods

Our assignment was to ‘design a model in which the Fishermen positively contribute to the eel recovery, can keep fishing and are being financially covered’ (ACT assignment). To be able to do so, we first had to figure out what an eel ranger programme would look like. We started by brainstorming about different tasks eel rangers could perform. Subsequently, we had to explore to what extent all these options were economically feasible. To determine this, it was important to get an overview of the social and political sphere around eel management, and to gain an overview of what the different parties thought of our suggestions. This could also help us find out who was responsible for funding and try to get an idea of how much this would cost them. The latter was particularly challenging to answer as information was hard to source and our timeline limited. Despite this, we still attempted to answer all three sub-questions.

To answer the main research question, two methods were used, the first is a literature study in order to gather secondary data which will be integrated into our discussion. The second method chosen was through semi-structured interviews. This is because semi-structured interviews allow for the researcher to address specific questions on the topic of interest whilst also giving the interviewee enough freedom to deviate onto other topics. This can be a key aspect as the new topics brought in by the interviewees can divulge relevant information that the researcher would not have known to ask (Kumar, 2019). Interviews also decrease researcher bias as quotes can be used from the interviewees, so their own words are used to describe their impressions of the eel ranger programme. The team made sure there were always two interviewers, and we were generally paired up according to the language as some interviews were in Dutch and others in English.

The sampling method used was that of purposive as well as snowball sampling. Having discussed with our academic advisor, some academics from the WUR who were involved in eel and fish conservation were suggested to us. We reached out to these and the ones who were available were interviewed. We also used the networks of our commissioner in order to find more interviewees, this shows that we used snowball sampling. Both of these sampling methods introduce researcher bias as they are non-random however due to time restrictions the team made a stakeholder analysis and decided to contact the stakeholders that were deemed most essential to the topic of research. In that way our sampling was very much purposive as we explicitly asked for interviews from bodies and people that we believed would have interesting information to provide us with.

Our data collection allowed for triangulation of data sources, this was ensured by speaking to multiple stakeholder groups, namely fishers, academics, NGOs and governmental bodies in the form of waterboards. This triangulation helps strengthen the validity of our findings as potential biases from each group are lowered. Interviewing fishers specifically took place very differently than other stakeholders as they were all in person and more politically charged. The Dutch-speaking researchers opted to allow a free-flowing conversation with some of the planned questions being asked when deemed suitable. This was in order to avoid mistrust with the fishers and avoid the abrupt ending of the interviews. In these cases, the interviews were not recorded and instead the researchers took extensive notes during the interview as well as after. These notes were then coded instead of the interview transcripts.

Data analysis was done by coding the interview transcripts inductively and deductively, using the 'Atlas.ti' software. This was used as the team already had some clear topics and themes they wanted to find in the transcripts. Inductive coding allowed us to make codes which were expected to be found in the raw data whereas deductive coding allowed us to discover new topics and themes which were either unexpected or unknown to us. As the whole team was involved in coding, each transcript was coded a second time by a different person in an attempt to standardise the process to an extent.

### 3.2 Strengths & Limitations

The limitations of our research are somewhat tied to the limited expertise in the topic by the team as well as our restricted timeline. The group did not hold any expert knowledge on the eel specifically, nor the political sphere on this topic when this project began. However, within 7 weeks of this project, significant amounts of knowledge were gained by the team. The group also wants to recognise they lack financial expertise. However, both of these factors were well known by our commissioner and attempts were made to the best of the ability of this group of students.

The use of purposive sampling also introduced some bias as our commissioner and academic adviser are more likely to have a network of people who share their interests. However, the team combatted this by also reaching out to participants independently of shared networks, such as the fishers and

DUPAN. Despite this, it is a possibility that the reputation of our commissioner, as an NGO vested in saving the eel, had an impact in who was willing to respond and sit for an interview (NGO 2).

The interviews with the fishers were significantly more sensitive and therefore we made decisions in the field that seemed to disturb the interview and participants the least. As previously mentioned, this means some of these interviews could not be recorded. This impacted our ability to code raw interview data and instead required us to transcribe our notes. This is likely to have introduced more bias as the researcher will have noted down the information they felt was most relevant, inevitably leaving some information out. This, however, was the only possible alternative to recording and some amount of bias is acknowledged and accepted when working with qualitative data.

The data analysis process was also limited by the lack of time, as each transcript was reviewed twice during coding when a third review would have been more thorough, especially as there were 6 different coders, reducing the consistency in the process.

### 3.3 Ethics

This project can bring up a few ethical concerns which we will attempt to address and acknowledge here in an effort to be transparent and honest. Firstly, eel fishing is a part of the livelihood of the main group discussed in this project and thus our advice could impact their lives, even if to a minimal extent.

We also recognise that as our team consists of members with mostly ecological and conservation backgrounds, we might be swayed to the side of eel conservation focused on the wildlife rather than the fishers. In order to combat this, we have acknowledged our probable bias and discuss it openly. Further, one of the teammates who is more focused on the social side of conservation in general, ensured that this consideration was always brought up. Additionally, the team aimed to meet the fishers in person and if possible, spend some time fishing with them in order to lessen the distance between the student group and the fishers. The latter only occurred once due to the busy schedules of the team and fishers themselves. Overall, by striving to deliver something we stand behind as a team we avoid the potential ethical problem of integrity that can come from the desire to deliver a satisfactory or overly positive product to the commissioner.

Besides these concerns, ethical matters of consent, anonymity, confidentiality and privacy were considered by the team. Before all interviews, participants were asked for their consent to be recorded and were also informed of their right to withdraw from the project at any time by contacting a group member. All raw data was stored on the Wageningen University portal and access to the report is only given to Good Fish, our academic advisor, the coach and the student group. The final report does not hold the name of any participant nor any recognisable details. The team also offered participants the opportunity to attend the final presentation session given to the commissioner, both online and in person. This was done with Good Fish's agreement. Dissemination of results to participants was not opted for as this research was specifically commissioned for Good Fish.

### 3.4 No-responses

At the start of our project, we planned to have interviews with numerous parties and individuals. While we received responses from most, sometimes we either did not get a response or we were redirected to their website instead of an interview. This was the case for DUPAN, who represent inland fishing and small-scale coastal fishing (NetVISwerk), the Dutch Association of Fish Farmers (NeVeVi) and the Dutch Association of Eel Traders (NeVePaling) (DUPAN, n.d.). We sent two emails, but we got no response from them. We also contacted the Sustainable Eel Group (SEG), but they said that they did not have time for an interview and directed us to their website. Another instance we did not manage to get an interview with was LNV (Dutch Ministry of Agriculture, Nature and Food Quality) in who

legislative power lies for this topic. The same holds for the NVWA (Dutch Authority of Food and Commodities), who are responsible for anti-poaching, but we could not get in contact with them. We also reached out to RVO (Netherlands Enterprise Agency) who are involved in sustainable development for companies, but they redirected us to their website. Lastly, we unsuccessfully reached out to shrimp fishers on Texel who made a transition to tourism.

In future research on this topic, we recommend reaching out to these parties again since they might still have relevant information that could help in setting up a ranger programme for eel fishers.

## 4. Results

### 4.1 General result

In this section we will present the results from the interviews without engaging in any discussion. Firstly, we will share our general results from the coding process of the interviews. Secondly, we will present our results for the four different groups of stakeholders that were interviewed. This was done in order to note whether and to what extent the different individuals belonging to the same group agreed or disagreed on the topics mentioned by the interviewers.

Our coding analysis ended with codes being categorised into four distinct groups, seen in table 1. A total of 24 codes was found in the end, for a complete list of these see appendix 1. In this research, we linked the amount of times a code was mentioned to importance of the topic among the interviewees.

Table 1: Table showing the four coding groups that were derived from the interview analysis and a short description of what they each encompass.

<b>Code group title</b>	<b>Description</b>
<b><i>Eel ranger tasks</i></b>	This code group included considerations on the possible alternative livelihoods' fishers could be involved in. Both positive and negative points were added.
<b><i>Funding sources</i></b>	This group was used for any codes concerning potential funding sources for this transition.
<b><i>Challenges to transition</i></b>	This code group includes topics that the team considered necessary to acknowledge if not tackle before a successful transition into eel rangers can happen.
<b><i>Outside topics</i></b>	This code group refers to topics that were recurring and relevant when discussing this topic, however they are not directly relevant to our research questions.

The most coded topics from the 13 interviews are presented below (Figure 2), showing that 'research' was the most coded topic as an alternative job, followed by the theme of trust, which was coded under 'challenges to transition'. The rest of the topics were mentioned at approximately the same frequency across all interviews.

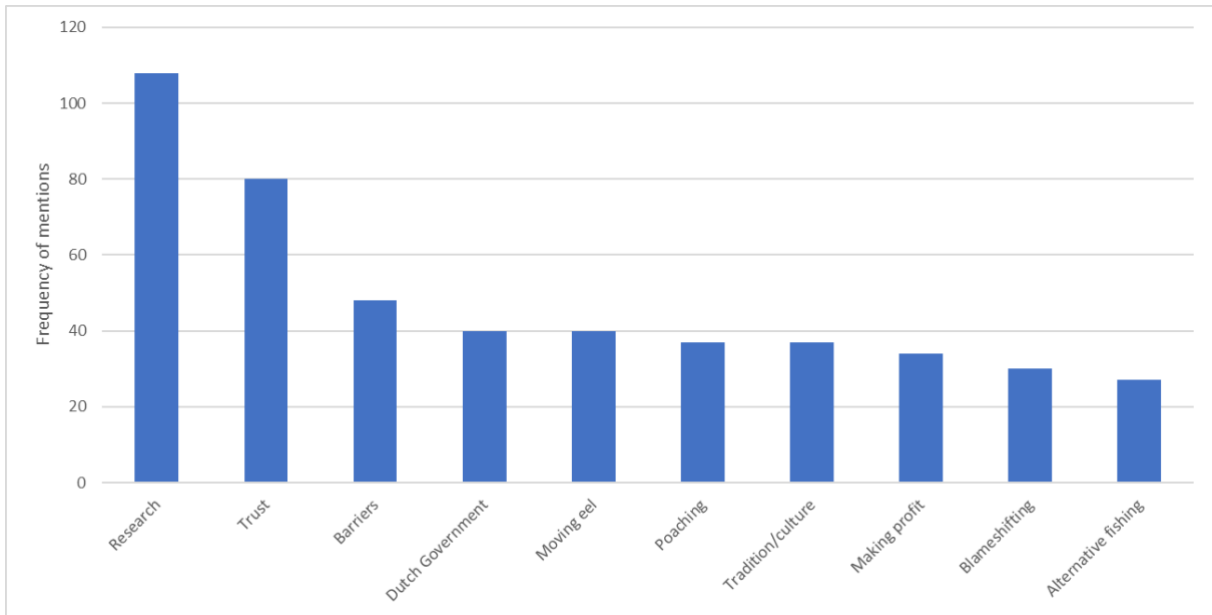


Figure 2: Bar graph showing the 10 codes that were found most frequently across the interviews and how many times these were found. For a list of all codes made by the team, see appendix 1, figure 1.

#### 4.2 Academia

Four academics were interviewed for the research done in this report. They are all involved in the topic, although their specialities varied among them. The areas of expertise were marine sociology, fisheries, fish migration and animal behaviour, among others. We found that the most mentioned topic by the academics was research, followed by trust and tradition/culture (Figure 3).

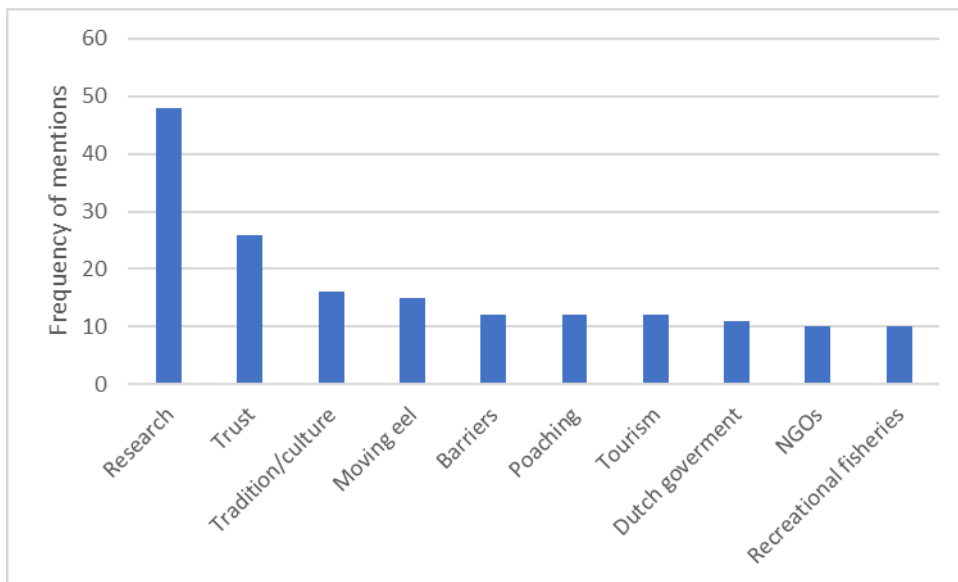


Figure 3. The ten most mentioned codes from the academia group.

Academics consider research as one of the best alternative jobs for eel fishers. This is of large relevance, since it is the academics who could conduct this research. We found that academics have already collaborated with fishers in the past in order to conduct research, and that overall, experiences have been fruitful. Inside research, some of the tasks that were mentioned were tagging & scanning, monitoring, following and measuring. It seemed to be a general belief among academics that the fishers have a lot of very useful knowledge about the eel. They said that they thought this knowledge

could be applied for research of either academics or the government. One of the academics mentioned that the fishers want to get involved in research to "create for themselves a positive image" (academic 1), while another said that they would be genuinely interested in it. Either way, the academics seemed to agree in the fact that eel fishers would be in favour of joining research. One of the academics mentioned that they have done research with fishers in the past and that, in his experience, he found it more convenient to have few but well trained and trusted fishers than to have many of them on the field. This, he said, is because in his experience, poaching and bad quality research are more likely to happen when there are many fishers involved (academic 2).

Trust was mentioned several times as an essential component for a possible future in which fishers could participate in the recovery of the eel. One of the interviewees mentioned that they are aware of a lack of trust between inland fishers and other stakeholders, which is something that does not happen as much with the marine fishers (academic 4). Academics said that they think the fishers do not feel respected and listened to, and that their knowledge does not feel recognised. However, they did say that the mistrust seems to be mainly directed towards the managers (government) and NGOs, not as much towards the scientists. In fact, they said that they think fishers want to have a good relationship with scientists, since they need their research for the eel to do well. In the same line, scientists need the information from the fishers to help them with their studies. All and all, the academics said that they have the same goal as the fishers, so there is a mutual goal.

A very important finding is that academics deeply appreciate the traditional knowledge from the fishers. They said it was essential that their traditions would not be lost, since it would suppose a huge loss of centuries-old knowledge, which can be useful for many fields, including research. However, it was emphasized that there is a deeply rooted tradition for not only fishing eel, but also eating it, which would make the transition from eel fishers to eel rangers difficult. It was pointed out that this comes from a long tradition of eating self-fished smoked fish, which is now narrowed down to only eating smoked eel (academic 1).

Barriers were seen as one of the main problems for eel conservation. They thought waterboards were already investing money in fish passages and other ways to make these barriers as safe for eel as possible. Regarding barrier establishment as an important conservation measure, they considered the projects of restocking and Eels over the Dykes to be a temporarily solution for them. None of the interviewees are involved in these projects, but they all are aware of them, with their opinions on them being rather positive. They were however concerned that the restocking was being done solely for maintaining the fishers' jobs and that it was not being done from a biological point of view. One of the academics thought it was not a good idea to use the glass eel from France, but he did think that the glass eels that arrive to the Netherlands could be placed upstream, as a sort of 'local restocking programme'. He mentioned he talked to eel fishers that were willing to participate in such a programme, but that currently it is illegal in the whole country to catch any wild glass eel without a special permit (academic 2).

Poaching seemed to be one of the academic's main concerns. They said they think there is a lot of poaching happening in the Netherlands, and that the eel is endangered by it. They also thought that no one truly knows the extent of this problem, and that it is difficult to tackle. Regarding the involvement of the fishers in poaching, there were different opinions. One of the academics thought it would be challenging to make fishers anti-poachers, since they would have to collaborate with each other, and he said there is a lot of competition among them (academic 2). Other academics considered it not to be a bad idea, since, they said, fishers have eyes on the water and are probably the ones with the most realistic information on poaching.

The main sources for funding mentioned by academics were the Dutch government and NGOs. Universities were mentioned once, while the European Union was not mentioned at all as a source of income for the future eel rangers.

### 4.3 NGOs

The NGOs group is made up of RAVON (Reptielen Amfibieën Vissen Onderzoek Nederland), Good Fish and a former WWF employee. RAVON is a conservation organisation focused on amphibians, reptiles and freshwater fish (RAVON, n.d.). Good Fish is an NGO focused on ensuring that people and food providers only sell fish that is sustainable (VISwijzer, 2022). The former WWF employee took part in a project that focused on an eel sales ban for large retailers in 2009. One finding in this group was that the alternative job for fishers most mentioned in the coding analysis was that of ‘research’ (figure 4). This is in part because RAVON already hires fishers to help them with research (NGO 1). RAVON also mentioned ‘poaching’ the most, though this was discussed as the general situation on poaching of eels in the Netherlands and not in the context of suggesting fishers become anti-poaching rangers. In fact, the interviewee openly stated that they “don’t really see the professional fishermen as rangers against poaching” due to the social networks that overlap between the two groups (NGO 1).

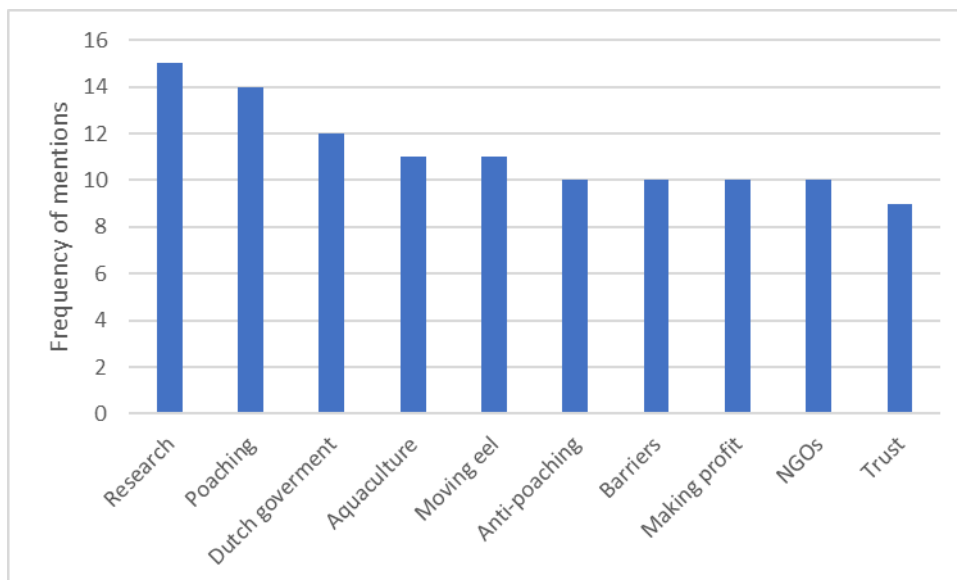


Figure 4. Coding results of the NGO interviews showing the 10 most frequent codes.

Individually, the Good Fish interview actually mentioned the alternative job of ‘anti-poaching’ the most and did not mention ‘research’. Another relevant theme in this interview was that of ‘tradition/culture’, stating that “if you are attacking fishing, you are attacking our Dutch identity” (NGO 2). This shows the complexities that surround eel conservation, which in turn show potential challenges to this transition. Both representatives of Good Fish and RAVON shared their thoughts on the threat of illegal eel fishing, in particular RAVON shared that they actively research poaching.

The WWF representative spoke more on the topic of skipping barriers and the Eels over the Dykes project as well as the importance of trust. Their opinion was that the process of restocking has had no scientific evidence showing its positive effect on the eel population despite having been practiced since “the 1930’s or 1950’s” (NGO 3). Further, they mention their doubts that the eels grown in captivity, for restocking purposes, would be able to find their way to the Sargasso Sea. When discussing an effort in 2009 to work together with the eel sector and WWF, the topic of trust was often breached, this was found both in the descriptions of trying to build trust with the industry and involving all the key stakeholders. Yet, there was also mentions of a lack of trust, displayed by a suspicion that the sector

simply wanted to work with WWF for the sake of their image without effectuating any changes, though it should be noted this was particularly toward the eel aquaculture sector.

All three interviewees agreed that the government was responsible for funding these possible alternative jobs. The Ministry of Agriculture, Food and Quality (LNV) and the Netherlands Enterprise Agency (RVO) were both mentioned; LNV's "action plan for sustainable fisheries" was stated by an interviewee (NGO 3). RVO was said to be able to subsidise the transition and more sustainable jobs of all eel fishers in the Netherlands (NGO 2). Also mentioned, was the responsibility of waterboards to help fund this transition, a sentiment echoed by the third NGO representative (NGO 3). The RAVON representative also provided information on how much fishers that help them with monitoring and research would get paid by them. One of the representatives also claimed that the responsibility of these costs should at least partially be the responsibility of the fishers themselves (NGO 3).

Our research attempted to secure an official number of eel fishers, or rather of all fishers who have a license to fish eel, as we have learned that there are no fishers who only live off fishing eels (NGO 1). Finding this number was particularly challenging as there is no recently published official list stating the number of fishing licenses that exist, nor to whom they were given out to, sold or rented. The estimates of the number eel fishers varied largely between participants though the most confident estimates were close to 80. This is essential information in order to consider alternative jobs as well as how much funding would be required in order to plan for a larger scale transition. The current income of fishers was hard to find and clarify as the team did not feel it was an appropriate question to ask the fishers that were interviewed. This was due to the frequently brought up lack of trust between researchers and the fishers but also of fishers toward science in general. Further, in order to keep their licenses, the fishers must make a minimum of €8500 a year by selling their catch and/or participating in research, according to Dutch law (NGO 1).

#### 4.4 Waterboards

In total three waterboards were interviewed for this report. The interviewed waterboards were Waterschap Zuiderzeeland, Hoogheemraadschap Delfland and Hoogheemraadschap Noorderkwartier. The focus during these interviews was on existing programmes that focus on eel recovery and how waterboards could (potentially) employ fishers to aid in this more.

One of the main topics that was discussed during the waterboard interviews was a fisher case where a waterboard 'bought' out a fisher and hired that fisher for research, amongst other tasks, in that area (reflected in Figure 5). This waterboard said this type of programme might be very specific and is difficult to apply in other regions as there are some requirements that need to be met and even then, the possibility to apply this is circumstantial (waterboard 1). One main requirement mentioned was that there must be a good relationship between the fisher and the waterboard. While the waterboards can decide whether to give the fishing rights to fishers, cooperation and trust between the two parties is the preferred way of working. The fisher also has to voluntarily decide whether they want to work with the waterboard on eel recovery, this cannot be forced.



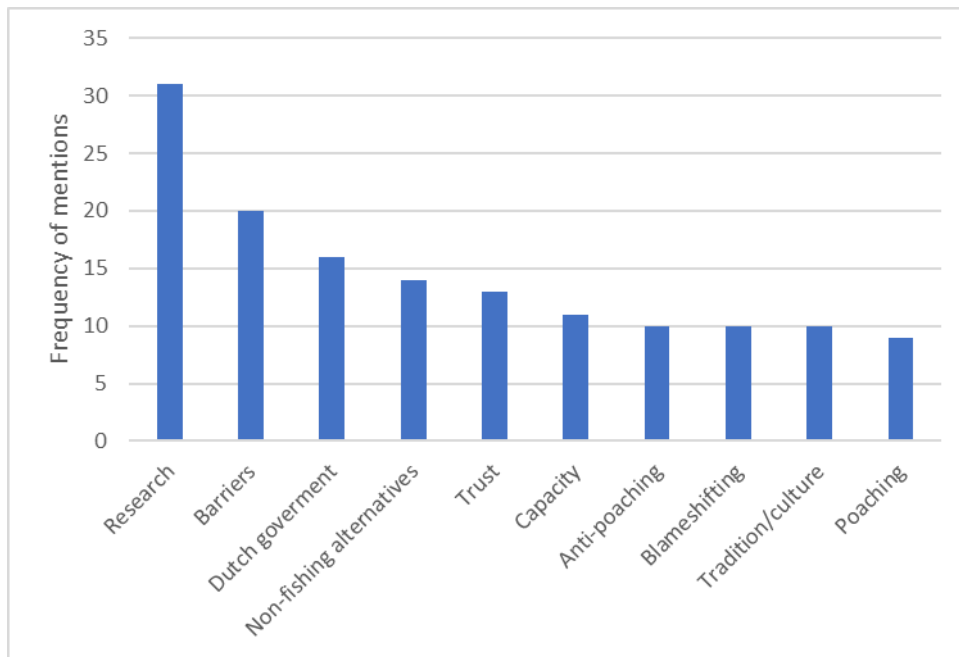


Figure 5. The ten most mentioned codes from the waterboards.

The capacity for waterboards to fund projects that include fishers in research and other job types can also be very limited. If there are only a few fishers this is realistically manageable, but for waterboards that have 20 fishers, it becomes a challenging task to finance all of them (waterboard 1 and 2). The waterboards also claimed they follow national guidelines and often do not have the funding to go further than these guidelines. And so, according to these waterboards, it does not fall under the responsibility to keep the fishers from fishing eel (waterboard 1, 2 and 3).

In one of the interviews the waterboard said they paid their fisher €25,000 per year for doing other jobs in their area instead of fishing there. This amount went up (unknown amount) because the fisher started doing more things for them. While presenting this to another waterboard they said this would not be feasible for them. If the Fisher’s Union (Nederlandse Vissersbond) would come to them with a plan to do this for about five fishers, this waterboard would seriously consider it with the union (waterboard 2).

The waterboards all said that their focus should be on tackling the root of the problem and not fighting symptoms of it. As a result, the focus of the waterboards we spoke to is on ‘fixing’ barriers and making them fish friendly, allowing the eel to migrate through them. This is also where some of the waterboards spend most of their money, on changing barriers. They view this as a long-term solution that will have the most benefit for eels. One of the waterboards actually shared that their board had decided not to be involved in projects such as Eels over the Dykes because they did not want to put funding toward it as they considered their turbines to be sufficiently fish friendly (waterboard 3).

Including fishers in research projects is something all the waterboards are already doing. While there are no strict rules on this, it is a common courtesy to include the fishers that fish in the area you do research in (waterboard 1 and 2; academic 2). The fishers were then used by the waterboards in monitoring, data collection and assisting researchers. One waterboard claimed that in 90-95% of all the research on fish in their area included the local fishers against some financial compensation (waterboard 2). For fishers this is really a side job, and it does not reduce the time they are fishing for eel. In addition, the waterboard said that you have to make sure not to include fishers in the areas of others since this might lead to some friction.

One of the waterboards we interviewed already had a fisher doing a lot of work outside of eel fishing. These projects include research, monitoring, fishing exotic species and maintenance of the region. The waterboards said an important thing to consider was capacity and skillset of the fisher in question. Some fishers are more flexible and able to help in different kinds of alternative jobs (waterboard 1). Not all these things are always something the fisher can do and this needs to be considered. Part of this can be helped in the form of assistance and supervision but this cannot solve all the problems. This being said, the overall opinion of the waterboards is that fishers can be used for a large variety of purposes given the proper assistance and good relationships. This statement was enforced by the other waterboards. Fishing alternative species, such as the invasive lobsters and crabs, is considered but not always a suitable solution. To fish on this species, the waterboards said they have to hand out different permits and other fishers that are already fishing on these species will only feel more competition as a result.

The waterboards had similar opinions on anti-poaching. They all concluded that this was an issue for the eel but very hard to get an overview of. Also, enforcement was something that they said did not fall under their responsibilities (waterboard 1, 2 and 3). While they would benefit from an antipoaching programme, there would probably not be financial support from the waterboards unless the costs would be very low. One waterboard also explained they would not have the capacity to focus on this specifically. It was mentioned, however, that fishers are likely to possess the information on where the best places are to poach and that fishers are the 'eyes on the water'. If the fishers are removed by an eel fishing ban, there would be even less insight on eel poaching.

#### 4.5 Fishers

Data was collected by interviewing three fishers. One of the fishers was an inland fisher while the other two were lake fishers. Two of the fishers were mentioned by one of the academia that was interviewed, and this academia believed them to be very interesting sources for our project. The last fisher was found through a contact of one of our group members. The goal of the interview was to ask questions about how the fishers view the current situation of the eel, what they thought of doing tasks like helping with research, anti-poaching and education/tourism and if they already have been involved with eel recovery programmes.

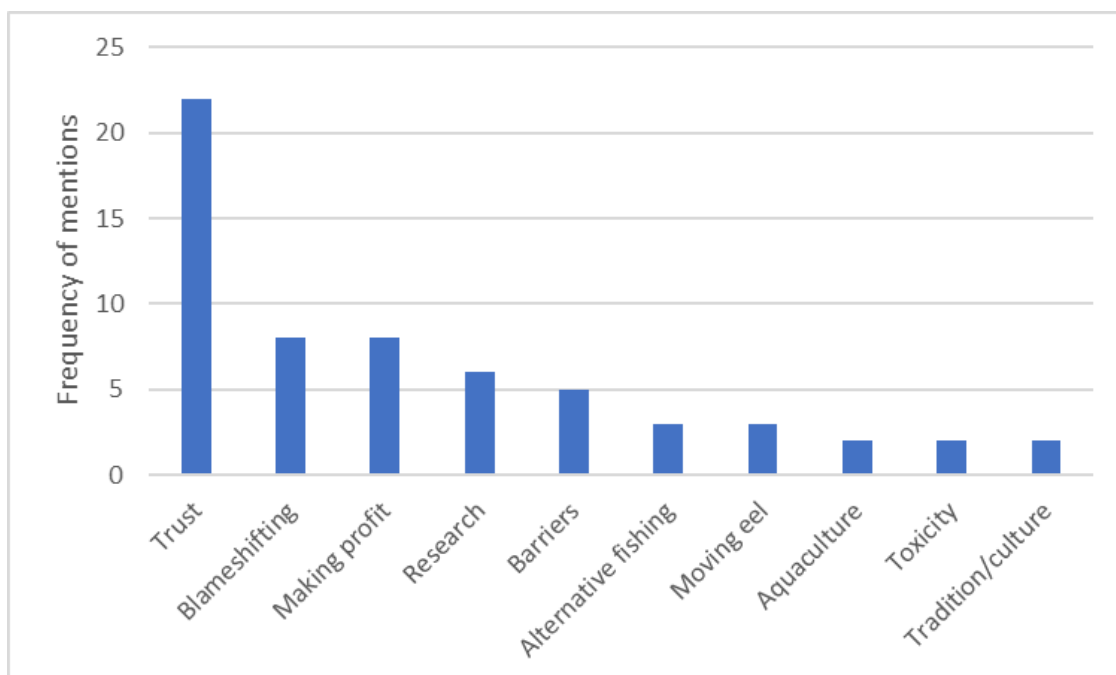


Figure 6. The ten most mentioned codes from the fisher interviewees.

Mistrust was the main component in the interviews of the fishers (Figure 6). The fishers stated that they feel like no one is listening to them and that they are being excluded. They believe that the government wants to get rid of fishers by, for example, making wind parks or by establishing islands like they did with the Marker Wadden. They also stated that researchers keep publishing the wrong information, in their experience their eel catches are stable, and even growing (fisher 1, 2 and 3). The three interviewees agreed that the eel population is doing fine and that it is actually researchers who are not experienced enough to do monitoring, and therefore are collecting unsatisfactory data. An example given was that researchers choose clear waters to do monitoring, but these contain fewer eels because of the lack of nutrients in the water and therefore this data is not representative to the actual number. Another aspect expressed, was that researchers also use the wrong equipment (lift net) to catch the eel and these nets are not right for catching eel. Additionally, a fisher stated that as they use much more equipment than researchers when they fish, and so their own data can provide a much more detailed overview. Two of the three fishers were willing to help with research in the future; one of them is currently involved in research and the other two having helped in the past.

However, mistrust toward science also played a role. Two of the fishers mentioned that the research they helped with, published data that differed from theirs. This caused one of them to back out of future research, while another remains willing to help, but only if they agree on the results prior to publishing. One of the fishers was working together with DUPAN on the project of Eels over the Dykes, while the others thought of it as a good initiative but did not participate. Two of the fishers did say DUPAN does good projects like Eels over the Dykes, but they did not support the restocking of glass eel.

The fishers we talked to said they did not understand why fishers are the ones being restricted, considering there are much bigger threats to the eel. The bigger threats they mentioned were cormorants (*Phalacrocorax carbo*), barriers, turbines and contaminated waters. The fishers think they are already quite restricted because the best months to fish are closed to them, and it leaves them with only 4-5 months to fish eel. This leads to the fishers having different occupations during the closed months like helping with research or fishing other species, but they preferably would not do this and just only fish for eel.

## 5. Discussion

### 5.1 Eel ranger tasks

Before being able to determine what would be the financial costs of the eel ranger programme, we first needed to determine what it would entail. We therefore explored which alternatives we could think of for fishers to shift to when they stop eel fishing.

These alternative jobs were brainstormed by the team, trying to find alternatives that kept eel conservation at the forefront whilst offering a realistic livelihood for the fishers. This brainstorm was partially influenced by the concept of a 'ranger', introduced by our commissioner. The term 'ranger' draws parallels with the wildlife rangers across African countries. This refers to people who used to hunt wild animals but now instead, protect them; sometimes even switching from roles of poachers into that of rangers. To do this, they often use their prior knowledge of the wildlife to do so (Kuiper et al., 2021). In this case, we believe fishers can use their traditional knowledge on the eel and sweet water habitats to improve the situation of this animal, and by doing so, becoming eel rangers. Jobs such as assisting in research can help increase knowledge on the eel population in the Netherlands, for ecologists and policy makers to make better decisions in this topic. Eel rangers could also help the eel

by trying to diminish other threats such as fishing for invasive species instead of eel or aiding with antipoaching efforts. All of these opportunities would ideally help the eel in and of themselves but to take it further, if fishers are involved in these activities, this is time and effort *not* spent on eel fishing.

The different stakeholder groups discussed some alternative jobs more than others, for example research was mentioned by all groups but non-fishing alternatives was only mentioned by fishers and waterboards (Figure 7).

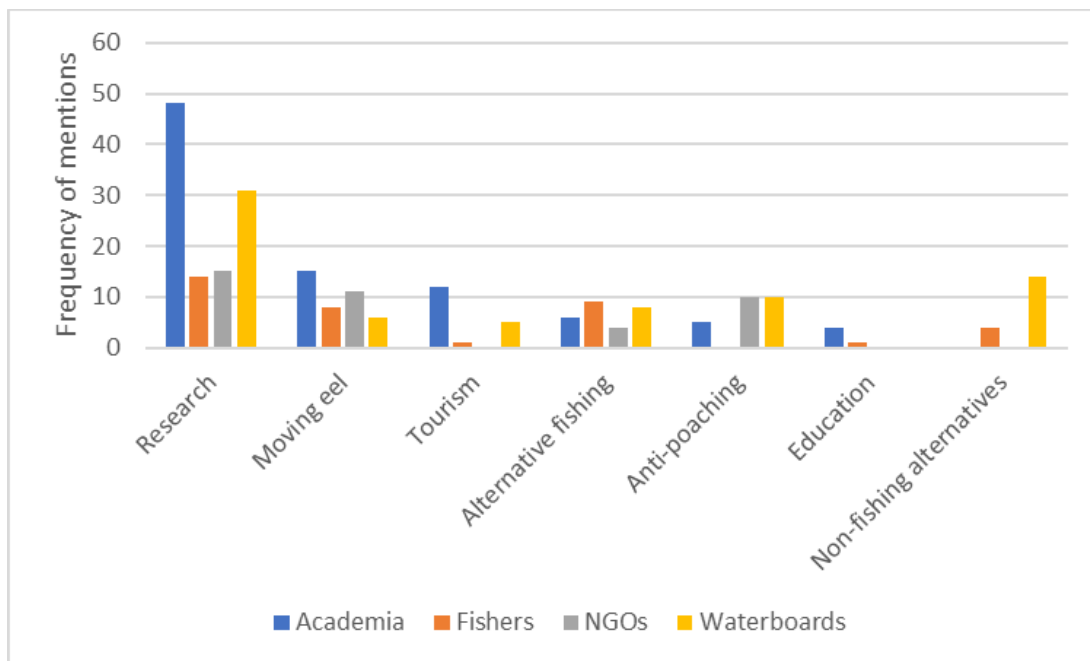


Figure 7: Bar graph showing the frequency of mentions of the alternative eel ranger jobs per stakeholder group.

In the following sections, these different alternatives will be described in detail. To further strengthen our arguments and in an attempt to provide context to these options, we will also use three case studies of how eel and salmon (another migratory species) fishing was managed across different countries: two eel management studies in Spain and Ireland and one in Canada on salmon fishing.

### 5.1.1 Assisting in research

Fishers have a lot of experience on the water and an extensive knowledge about the biology of eels and where to find them (Kuijs, 2020). Besides being essential for eel fishing, this knowledge can also be very helpful in research, as catching eels in various life stages often is part of research projects. In this way, fishers can still apply their fishing skills and knowledge, but it would be used for different purposes (NGO 1; T. Murk, personal communication, October 3<sup>rd</sup>, 2022). Examples of research projects they can be involved in, are contributing to data collection for scientific studies, and population indicators and applying the best ways to catch and count specimens. This is an alternative that already is applied quite widely by different organisations, for example water boards, research institutes and non-governmental organisations (e.g. van Keeken et al., 2020; noor & van Keeken, 2021). A common research topic in such studies is testing the effectiveness of fish passages for glass eels (Waterboard 1). This can be done by capturing and marking glass eels on one side of the barrier and use fykes to catch all fish that passes the migration pathway, to test whether the marked glass eels manage to get at the other side. In the same way, effectiveness of fish passages for outward migration of silver eels is tested (van Keeken et al., 2020; Griffioen & van Keeken, 2021).

In our interviews, the fishers pointed out several times that they feel unheard and that their experiences are not taken into account, although professional fishers are engaged in some research projects (fisher 1 and 3). They provided several arguments about why the methods used by scientists are non-ideal for getting insight into the population trends of the European eel (fishers 1, 2 and 3). They also suggested that the historical data on their eel landings should be included in the trend data on eel populations, additional to the glass eel recruitment data (fisher 1 and 3). Engaging fishers into the research more might reduce this mistrust. This might be especially successful when fishers are not only engaged in data collection, but also in the interpretation of the data. The fishers mentioned that if they contributed to data collection, they did not see the patterns they found in their own data back in the report at all (fisher 2). If they are able to collaborate more, this can be very helpful. Possibly, the patterns they found are not included in reports because they show local phenomena, which are not in line with the overall pattern. When fishers are involved more in the data processing and interpretation phase, they will be able to see this themselves, increasing their trust into the research data as well.

In several parts of the country, there are plans to establish so-called 'eel reserves'; unpolluted, wellconnected freshwater bodies in which eel fishing is banned year-round (Schollema et al. 2013). Until now, only one has been established. It is located in the Dutch provinces of Groningen and Drenthe, in the north of the Netherlands (Schollema et al. 2013). The establishment was realized under the responsibility of Sportvisserij Nederland (Schollema et al. 2013). From one of the interviews (interview academic 1), it was stated that these reserves are showing indications of positive effect on the eel population. Furthermore, the RAVON foundation is intending to establish more. The reserves may lead to the emergence of a new research task for the fishers, as the intention is to continuously monitor the eel populations within them, so test whether they are effective.

Scientific research on eel can mainly take place in two specific moments of the year. The first moment is in spring, the period in which glass eels arrive at the coast and try to enter into their freshwater habitats (Quak, 2011). The second period is in autumn, which is the period in which silver eels migrate outwards towards the sea to start their migration to the Sargasso Sea (Van Ginneken & Maes, 2005). This latter period is the period of the current ban on eel fishing (which is in place in September, October and November), making it especially suitable to provide fishers with alternative jobs (Kuijs, 2020). This means that involving eel fishers in scientific research on eel specifically, will not provide them with a year-round job. Therefore, it would be interesting to look for other research tasks they can perform in other periods of the year. For one of the waterboards, for instance, a fisher is monitoring the effects of certain measures to create new fish habitats during summer (waterboard 1). Almost all inland eel fishers fish for other species as well (Fishers 1,2 and 3) so their expertise will expectedly be broad enough to join other projects also.

Another aspect to keep in mind is the amount of compensation that fishers get for contributing to research (see section 6.2). There are examples of fishers that started poaching because their compensation for doing research work was too low, and they still had to make a living (academic 3).

Until now, fishers involved in research are mainly involved in data collection (Fisher 1, 2, 3; NGO 1; academic 1). Although this is a form of engagement, they still do not feel truly included in the research, for instance because they do not see the results they collected back in the reports. To provide them with the opportunity to gain more insight in and become involved in research, we advise to try to involve them more in data analysis and interpretation. This provides an opportunity to build trust between researchers. Additionally, the extensive experiential knowledge of the fishers (Kuijs, 2020) will be integrated better in the research in this way.

Combining local and scientific knowledge can result in better management of local resources. The case of Ireland Eel Management Plan is relevant as the country completely banned eel fisheries in July 2009 (FishSec, 2021). Following this, around 200 licensed fishers were left without a job. The “Eel Fisherpersons Support Scheme” partly paid, over three years, fishers who had a license in 2007 (Inland Fisheries Ireland, 2018). This started in 2018 and was backed up by EU funding, though it did arrive 9 years after the ban. In addition, both Inland Fisheries Ireland (IFI) and the Electricity Supply Board (ESB) hired former fishers to carry out catch-and-release programmes, trap and transport operations and eel surveys. Since 2016, a network for scientific eel fisheries has been established by IFI, involving fishers due to their historical and practical understanding of eel ecology (Rice, 2016). This form of citizen science recognizes the value of traditional knowledge in order to preserve both the history of eel fishing but also the wild population.

### 5.1.2 Moving eel: Restocking and Eels over the Dykes

Restocking and ‘Eels over the Dykes’ are two initiatives through which fishers can help eels to safely pass migration barriers. Of course, these are only temporary solutions, as the real solution is to remove these barriers. Completely solving the barrier problem will still take quite some time. While the Eels over the Dykes project and restocking seem ideal, they should be evaluated critically before being applied. For instance, it is clear that these projects are only effective in unpolluted waters. In polluted waters, eels will accumulate toxins into their fat layers, which reduces their chances of being able to reproduce (Geeraerts & Belpaire, 2010). Therefore, helping eels skipping barriers in polluted waters might not be very effective in supporting eel recovery. As most other aspects are specific for these projects, they will now be discussed in separate sections.

#### *Restocking*

In general, our interviewees feel restocking could potentially be a good action for the recovery of the eel. Some of them openly supported this project (academic 1), while others did not find it a good action at all (academic 2). The latter’s concern usually came from the circumstances of the restocking: there are many cases in which restocking can be futile. This happens if the eels are transported to contaminated rivers; these eels would probably not be able to reproduce successfully (NGO 1; T. Murk, personal communication, October 3<sup>rd</sup>, 2022; Geeraerts & Belpaire, 2010). Another case is eels being released in closed off bodies of water, where they would eventually be fished and would not be able to get to the sea. We also heard a story about glass eels being released in unrealistically high densities due to organizational constraints (Fisher 3). This also would not be effective. Finally, there are concerns about the effectiveness if the glass eels are released in areas in which eel fishing still takes place. In that case, many of the restocked eels might be caught again later in their live, not contributing to reproduction (NGO 2). Although the effectiveness of restocking as a whole is unknown, these factors clearly compromise it, and thus should be taken into account if it is still applied.

In the Spanish river case (Garrido et al., 2020), aquaculture farms grew the glass eels into elver eels, and then fishers were responsible for releasing the elver eel in inland waters. This was done in collaboration between the regional government, the fishers and the aquaculture sector, which helped build trust among the different parties. This collaboration was also useful since the fishers’ years of knowledge and expertise were put to use in helping the eel population. We consider this a ranger opportunity for fishers. If restocking is going to continue being done, using the fishers’ knowledge makes it most likely it might contribute to the conservation of the eel. It would even be a source of income, a way to keep the fishers in the water and apply their traditional knowledge, thus not losing this relevant information that generations have carried.

#### *Eels over the Dykes*

The Eels over the Dykes project started in the Netherlands back in 2011 in the region of Friesland (DUPAN, 2012). This project consists of placing the grown, reproductive silver eels over the different migration barriers, for them to get to the sea. The aim of this project is to allow them to get to the sea and initiate their migration, so that they can reproduce in the Sargasso Sea. We learned that there are different participants involved in this project: DUPAN, watching over the process, some fishers that catch the eel and place it over the dyke, and volunteers from Sportvisserij Nederland, which are then to control the release of the fish.

Overall, the opinion of our interviewees was rather positive. They thought of this case as something positive since action was taken (interview academic 1, T. Murk, personal communication, October 3<sup>rd</sup>, 2022). Fishers seem to be in favor of this project as well (fisher 1, 2, academic 4, NGO 3), and some are already participating in this project (fisher 3). It was mentioned by an inland fisher (fisher 1) that they do not participate in the initiative because they do not fish near barriers, but that they still support it, since they see the barriers as the biggest threat to the eel. However, it was claimed that only 1% of the eels that get to the barriers would be caught, the other 99% would have to face the barriers by themselves (fisher 1). Waterboards also seemed to agree with this practice, and some of them already do it in collaboration with fishers (waterboard 2).

Although the general feeling is in favor of translocating eels over barriers, there are also some concerns. There is no evidence that the moved eel would be able to behave naturally and reproduce, and this is especially the case of eels with high toxic levels. There is no proof of this because of how much of the eel's life cycle is unknown. However, there are indications that highly toxic eel would not be able to reproduce (Geeraerts & Belpaire, 2010) One of the waterboards seemed to be aware of this, since they are only involved in projects with eels that are not coming from contaminated waters (waterboard 2).

Taking everything into account, we believe that moving eels over the dyke is something the fishers could be involved in. There seems to be an agreement among stakeholders about this project, including the fishers themselves. If done correctly, it seems like this could be an opportunity to help with eel recovery. However, special attention should be paid to where the eels come from and their levels of toxicity.

### 5.1.3 Alternative fishing

Almost all eel fishers do not rely completely on eel fishing. To be able to sustain their livelihood, they fish on other species as well (Fishers 1,2 and 3). If fishers would reduce their eel fishing, a possible way to compensate might be to shift to or at least focus more on other species. From an ecological point of view, it should be realised that this leads to an increased fishing pressure on the populations of these alternative species. This might be problematic, unless fishing takes place on non-native, invasive species. Increasing the fishing on them might reduce their populations, which is likely to be beneficial for the ecosystem as a whole. In the Netherlands, two important invasive species in freshwater ecosystems are the Chinese mitten crab (*Eriocheir sinensis*) and several species of non-native crayfish (species from superfamilies Astacoidea and Parastacoidea). Therefore, commercial fishing might be an interesting way to control their populations (Clark et al., 2009; Gerhardi, 2011). It should be kept in mind, however, that the permits that are given to fishers need to be changed and this can be difficult to achieve (waterboard 1).

Especially the mitten crab is a species that is already fished for quite a lot of eel fishers. If they would need to compensate for a loss of eel fisheries, these fisheries would need to increase. This is very promising, as in certain parts of the year, mitten crab has a higher market value than eel. In 2019, the average price for mitten crab on the Fish auction on Urk was €17,44 per kilogram (Zaalmink & Rijk, 2018), whereas for live eel, the price lies between €6 and €11 per kilogram (European Commission, 2021).

However, it should be noted that the price for mitten crab strongly fluctuates. The highest prices are paid from September to December, in which generally €20 to €22 is paid for a kilogram of Mitten crab (Zaalmink & Rijk, 2018). In spring, prices are lower (€7 to €10 per kilogram) due to a lower demand from China and a smaller average body size in this part of the year (Zaalmink & Rijk, 2018).

For fishing mitten crab, large fykes, which are also used for eel fisheries, are suitable. In contrast to eel fisheries, for which these fykes need to be clean, crabs can be caught with nets overgrown with algae as well (academic 3). However, the main period in which mitten crabs could be caught, and in which their value is highest is during their migration period in autumn (September to November). This is actually the period of the closure of the eel fisheries (Kuijs, 2020). Therefore, fishing crabs in this period is not allowed with this regular gear, because eels would also end up in the nets (Jongbloed et al., 2017). Since a few years, it is allowed to fish for crabs in the period using adjusted gear, out of which eels are able to escape (Jongbloed et al., 2017). Additionally, crabs might damage the nets with their pincers (academic 3). Therefore, the nets need to be repaired more often, meaning that more working hours are needed (academic 3). To prevent this, some fishers have been experimenting with nets from other, stronger materials, like dyneme (academic 3). We have also seen ourselves that mitten crabs end up in the same nets as silver eels (fisher 3). Partly, a shift to crab fisheries can thus be made using the same gear, but for a more effective shift, it might be interesting to buy fykes from stronger materials. To make this more attractive, a financial compensation might support fishers in buying this material.

Something to keep in mind regarding fishing for mitten crabs is that, like eels, they accumulate a lot of dioxines. For that reason, the fisheries on crab have been closed together with the eel fisheries in polluted areas in the Netherlands in 2011 (Hoogenboom et al., 2015). Indeed, Hogenboom et al. (2015) showed that in these polluted areas, the dioxin concentration in the meat of the crabs is generally higher than for crabs in clean waters. According to some sources, they might even accumulate more dioxins than eels (Tinka Murk, personal communication, October 3<sup>rd</sup>, 2022). This is something to take into account when crab fisheries will be expanded. However, most of these dioxins accumulate in the brown meat of the crabs, which in principle often is not eaten. The concentrations in the white meat are generally much lower (Hoogenboom et al., 2015). Further research to investigate whether a market could be set up for only white crab meat could be set up. If possible, the legislation might be adapted to allow Mitten crab fishing in polluted areas again. In that case, however, it is also important to set up an information campaign so that consumers are aware that they should not eat the brown meat of these crabs, because these would contain too much toxins.

The second (group of) invasive species that could substitute for a loss of eel fisheries are the crayfish. Within the Netherlands seven different invasive crayfish have been registered, of which the most important ones are *Orconectes limosus*, *Orconectes virilis* and *Procambarus clarkii* (Good Fish Foundation, 2019). However, according to one of the fishers we spoke, there is hardly any market for it yet. Only a few luxury restaurants are interested in it until now (fisher 3). Therefore, it might be important to expand the market using campaigns or financial triggers, so that their fisheries can be expanded more easily. Other projects of our commissioner also focus on setting up such a market (Good Fish Foundation, 2019).

Something else to keep into consideration is that commercial crayfishing will be focused on large crayfish (Gerhardi, 2011). This means that the small crayfish remain (Gerhardi, 2011), and large crayfish from elsewhere might recolonise (Moorhouse & Macdonald, 2010). One of our interviewees expressed their concerns that this might lead to these small crayfish suffering less competition from adult crayfish (waterboard 1). This would result in them growing faster and consuming more plant material. Their concern was that in this way, fishing for crayfish might even increase their impact on the ecosystem.



Therefore, the way in which the fisheries for crayfish will be set up should be considered carefully, to make sure that is also effective from the perspective of landscape managers. More research would be needed to develop an effective management strategy. Finally, a key consideration here is that if alternative species are fished instead of the eel, then the cultures and traditions that come from eel fishing risk disappearing.

#### 5.1.4 Anti-poaching

One of the alternative jobs we thought of was for fishers to participate in anti-poaching efforts. This would entail different efforts, depending on the interviewee asked, such as guarding the waters or working together with the police. This is strongly influenced by the use of the term 'ranger', which, as previously mentioned, has classically referred to reserve guards who defend wildlife against poachers (Kuiper et al., 2021). With illegal eel fishing being a significant threat to the recovery of the eel, this seemed to be a suitable alternative that reduced eel fishing whilst also trying to tackle the illegal fishing (Feunsteun et al., 2002).

Our participants had quite different views on the likelihood of this alternative job. Two interviewees believed that this would make sense and also had the potential to expand to larger scales (NGO 2) and the other participant suggested that limiting fisheries without tackling poaching was not sensible "so perhaps it's possible for fishers to play a role in this anti-poaching" (academic 4). Contrastingly, a third participant felt that tackling illegal fishing would not be feasible unless all eel fishing was banned. That way "any eel you would see go around in a market you'd know that would be illegally caught eel" (NGO 3). This makes sense as it clarifies that any eel sold has been caught illegally, allowing the tracking and tracing back to poachers much simpler. Additionally, toxicity levels could be used to distinguish wild specimens from the aquaculture stock (T. Murk, personal communication, October 3<sup>rd</sup>, 2022). However, this also entails that eel fishing would be completely banned, which would in turn lead to the loss of culture and traditional knowledge that comes from wild eel fishers. Even amongst participants who believed anti-poaching could be a good alternative, the path there is not clear without risking the loss of culture.

On the other hand, there were three participants who disagreed with this substitution. The first interviewee stated that the main issue to consider before involving rangers is to gather more data (academic 2). The other worry this participant voiced was the possible conflicts that could arise if fishers are expected to work together due to an existing competition between them (this of course assumes they would work together on a single ship). These concerns are valid as anti-poaching efforts need to be well considered as they can be dangerous to get involved in (T. Murk, personal communications, October 3<sup>rd</sup>, 2022). Therefore, gathering more data seems a wise first step. One of our participants specifically explained that they did not think this could work because "Some fishermen are very well integrated in the network of poachers." (NGO 1). This means there are socio-political ties in place that would make it very unlikely that the fishers would agree to work that pits them against poachers. This participant specifically mentioned the backlash they expect fisher would get from other poachers if they were to be 'whistle-blowers', including having their fishing materials sabotaged (NGO 1).

In the Canadian case study (Cote et al., 2021), the wild salmon (*Salmo salar*) population in the National Park of Terra Nova had continuously decreased since the 1970s. Various conservation measures were taken such as mitigations on the recreational and commercial fisheries and restocking. These had little success since the real threat to this migratory species was found to be poaching. To tackle this, the local community and park managers went through public consultation to discuss fisheries management. Increasing the number of anglers on the river contributed to effective surveillance and functioned as a further deterrent to poachers. This study found that the salmon population recovered

after implementation of community engagement. Adding the social-ecological approach added minimal cost to the monitoring programme and poaching decreased substantially after the plan was implemented.

In contrast, examples from Uganda and India show that corruption is not uncommon in the form of rangers and poachers working together to increase both their profits (van Uhm & Moreto, 2018; Dutta, 2020). This is something that would need to be very carefully considered if the anti-poaching route were taken as an alternative job for fishers. Beside this, poachers and rangers can often come from similar social networks (as seems to be the case according to this participant) which means reporting poachers can cause serious harm to the rangers' social life (Dutta, 2020).

Considering this information from both the literature and the interviews, the researchers do not find anti-poaching to be a particularly straight-forward alternative for the livelihood of fishers. It seems the Canadian case study was unique because the poachers were completely detached from the community involved, whilst, based on our data, complex social ties and networks exist in this sector across the Netherlands. Furthermore, it seems for anti-poaching to be successful as an alternative job, a complete ban on wild eel fishing would need to take place. This is not a suggestion this team stands behind, as there is no guarantee anti-poaching would be successful (see paragraph above). Funding for this alternative may also be hard to secure as one of the waterboards stated they would not put funding aside for anti-poaching as it did not fall under their directive.

To conclude, we do not advise to prioritize an anti-poaching programme while setting up an eel ranger programme. Due to social networks in which both poachers and fishers are present, and because a lot of effort is needed to occupy the fishers with the knowledge needed for it, we conclude this is not a very realistic ranger task.

#### 5.1.5 Non-fishing alternatives

There are other job alternatives that are unrelated to fishing. As mentioned in the result section, fishers can be used for a multitude of tasks depending on the fisher's qualities, personality, the company hiring and their current relationship (waterboard 1).

Waterboards are obligated to participate in water quality monitoring. This is referred to as KNW, which stands for Koninklijk Nederlands Waternetwerk (Royal Dutch Water Network in English). The KNW regularly monitors the Dutch waters and fishers sometimes already assist in this. Not every fisher has the capacity to do so but this can be helped by pairing less experienced with more experienced people from KNW. This way the expertise from the KNW on how to monitor is combined with the fisher's knowledge on where to monitor, what to look for and the fisher will be financially covered.

Another job type that was discussed in one of the interviews was maintenance of the waterboard's waters. This can range from removing weeds, which block certain passages and cause floodings, to removing sunken ships. Normally the waterboard has to arrange an external party for these kinds of things. A waterboard said that when the removal of weeds was done by such external party, this was done as fast as possible without thinking of the ecological consequences, resulting in murky water. A fisher could also do this using his expertise of the area. This includes where to (not) cut the weeds and how to do this in the most ecological way possible (waterboard 1). It was also said that fishing vessels have the equipment available in the form of cranes and hooks to remove sunken boats and fishers could then be used for this instead of hiring an external party.

One fisher also indicated that he was willing to work more as a consultant for the waterboard. Depending on the fisher, this could be very helpful considering the fishers have significant and detailed knowledge on what is happening on the water.

These alternative jobs are often requested by an external party. This means the waterboards are not always involved in what a fisher is doing. Waterboards do, however, always recommend these external parties to include and ask fishers to assist.

The possibilities to provide fishers with water-related, but non-fishing alternatives might be very interesting as part of the eel ranger programme. However, it is always important to consider the specific situation, to make sure that the jobs offered to them suit the fishers.

## 5.2 Finances

To be able to implement the beforementioned alternatives for eel fishing, it is important to know how these should be financed and by whom. Further, it is important to know what the current financial situation is for eel fishers currently. This information was hard to come by in its entirety, so some calculations are made by the team in an effort to find the most accurate numbers. The number of wild eel fishers in the Netherlands is estimated at 80 fishers, as mentioned in our results. The salaries of the fishers will be estimated based on the total catches of eel and the average amount of money raw eels can be sold at (table 2). It needs to be considered that these calculations are assuming that all fishers are catching the same amount of eel, but this is not the case (European Commission, 2021).

Table 2. Commercial landings of yellow and silver eels in the Netherlands and its average market price.

Eel catches (tonnes/year) by wild eel fishers in 2019	Range of price of eel (EUR/kg) in 2019	Average price of eel (EUR/kg) in 2019	Source
	6.5 - 11	9	European commission report (2021)
~484			ICES report (2021)

According to the average price of live eel, fishers would make around €54,450 per year if they caught 6,05 tonnes of eel a year, based on the latest market price found and the assumption that there are 80 wild eel fishers. However, the report states that it is only silver eels that can reach the higher end of the range between €9 - 11 per kg. The lower end of the range is €6,5 per kg of live eel, this significantly decreases the overall salary (Table 3).

Table 3. Range of salaries of fishers per year assuming all fishers catch the same amount of eel.

Upper range salary of fishers (based on a selling price of 11 EUR/kg for live eels)	Lower range salary of fishers (based on a selling price of 6,5 EUR/kg for live eels)
€66,550	€39,325

This does not include the operational costs that fishers have such as fuel, boat maintenance, nets, amongst others. We were unable to find an accurate or estimated operational cost value due to time restrictions of this project. This however is an essential value to understand the net income of fishers.

An important consideration to keep in mind when discussing salaries and ranger tasks is that in order to be registered as a professional fisher, a fisher has to meet two important criteria. The fisher must have an area of 250 hectares and a gross income €8,500 from either selling the fish caught in this area or through payments received for assisting in research on fish stocks (RVO, 2022). According to these

criteria, the fisher could then lose its registration as professional fisher if a big part of the income is generated through anti-poaching and non-fishing alternatives such as area maintenance. This should be an essential consideration when deciding on how to include fishers more in eel recovery.

In the following sections we will therefore provide a first description of the costs that need to be made and which parties can be involved in covering these costs. We have not been able to provide values for the costs due to time constraints, but nevertheless, we provide a first overview.

### 5.2.1 Research monitoring

If fishers become involved in research of universities, research institutes or NGOs, they will fish, but not make a profit, as they will not sell the fish they caught. Therefore, they should be provided with an income in another way. It might be easier for small scale fishers to make this shift to research as they need less compensation in comparison to larger scale fishers. During one of the interviews with an NGO, we discussed an example about how this was done. In their project, fishers were paid €50 per hour (NGO 1). This is a net amount, excluding taxes and other costs (travelling costs, equipment etc.) that needs to be made. In principle, this should not be that much, because fishers will own much of the gear needed for the monitoring. Taking this income as a reference, this means that a normal working day of eight hours would pay them €400 per day. For this NGO, the fishers mainly participated in projects which were specifically targeted to the eel, and hence took place only a limited number of weeks per year (see before). This means that within their projects, often €20,000 to €30,000 is reserved for fishers, meaning that they are employed for between two and a half and four months a year (NGO 1). For this NGO, these research projects take place on a project basis, meaning that they are only running for one or several years, as long as the funding lasts. Funds for these projects are for example provided by the national postcode lottery (NGO 1) as was the case for Good Fish.

If more equipment than that which is already owned by fishers is required then, costs should be covered by the organisation which conducts the research. Probably this will be equipment an institute or university already has themselves, so probably the costs of this will not be very high, but they still need to be taken into consideration. Furthermore, observers from external parties might be needed for research projects and these people need to be paid as well. In different interviews (waterboard 1, NGO 1) it was said this is done by volunteers from angler associations. If this 'arrangement' could be continued no additional costs would be tied to this.

### 5.2.2 Restocking and Eels over the Dykes

Restocking and Eels over the Dykes are ongoing initiatives from the government and DUPAN. For restocking, LNV sets aside an amount of €375,000 each year to buy the glass eels from France, which are then released in the Netherlands. Fishers are already used to release the glass eels, and this should then continue while getting financially compensated. What the fishers are currently paid is unknown and therefore an estimate would be €50/hr. This salary would also be the same for the fishers that help with the Eel over the Dykes project. The fishers already have the equipment needed for Eels over the Dykes. Therefore, this would not entail extra costs to get other equipment.

### 5.2.3 Alternative fishing invasive species

Another task for eel rangers might be fishing invasive species, like crayfish or the Chinese mitten crab. Especially because the Chinese mitten crab is already being fished commercially, but if it should replace eel fishing, it should be expanded. In principle, this means that establishing this alternative form of fishing will not be that expensive. However, as explained before, crab fishing currently takes place with the eel fishing gear, which cannot be used during the closure of the eel fishing between September and November. To increase the crab fishing period for the fishers, their equipment must be adapted so it contains an escape opening for the eel (Jongbloed et al., 2017). Additionally, fishing gear from

stronger materials might be more effective in crab fishing, because stronger nets will be damaged by crabs less often. To support fishers in shifting to fishing invasive species, financial support for buying stronger gear and adapting it, might be a good idea. Again, it is hard to determine how much extra costs this will exactly bring. The legislative changes and the information campaign related to crab consumption will add to the costs as well.

#### 5.2.4 Anti-poaching

To engage eel rangers in preventing eel poaching from taking place, some other steps are needed. To be able to combat poachers, eel fishers should first follow an educational programme, as they would need police-like skills of special investigators (NGO 1). Fishers need to be able to merge their traditional fishing knowledge with their newly acquired knowledge, in order to properly grasp and tackle poaching. Such a training programme would likely take some time and effort from the fishers. It will also require funding from the organisers. The questions then, is whether this would work. The fishers we spoke to do not believe the eel population is decreasing, which means conservation measures would not be necessary. Additionally, fishers who spend time on this educational programme should be compensated since they will be spending less time fishing. The fishers might also be provided with extra equipment which they need in order to be more effective in surveillance and this will bring some extra costs.

#### 5.2.5 Non-fishing alternatives

Fishers that could participate in the maintenance of the habitat of eels, also would earn €50/hr and should be paid for by the waterboards when these habitats are situated in inland waters, while Rijkswaterstaat should pay when they are situated at the IJsselmeer. The regular budgets of these organisations can be used to pay for the fishers that participate instead of external agencies. It should be further researched, however, if fishers will cost the same as these external agencies. Another thing to keep in mind is that depending on what kind of tasks the fishers will do, they might have to be educated, which will bring more costs. One task could entail mowing waterways of which the costs are shown in table 1 in appendix 3 (Beheerplan Watersysteem, 2021).

### 5.3 Legal responsibility (funding, enforcement, decision making)

After having considered what costs are involved in the different tasks that 'eel rangers' can do, the next question will be which parties are responsible for covering these costs and setting up these programmes. The programme intends to simultaneously engage fishers in eel recovery, while sustaining their livelihoods and cultures. To ensure both goals are reached, responsibilities and costs should be covered by whichever parties are responsible.

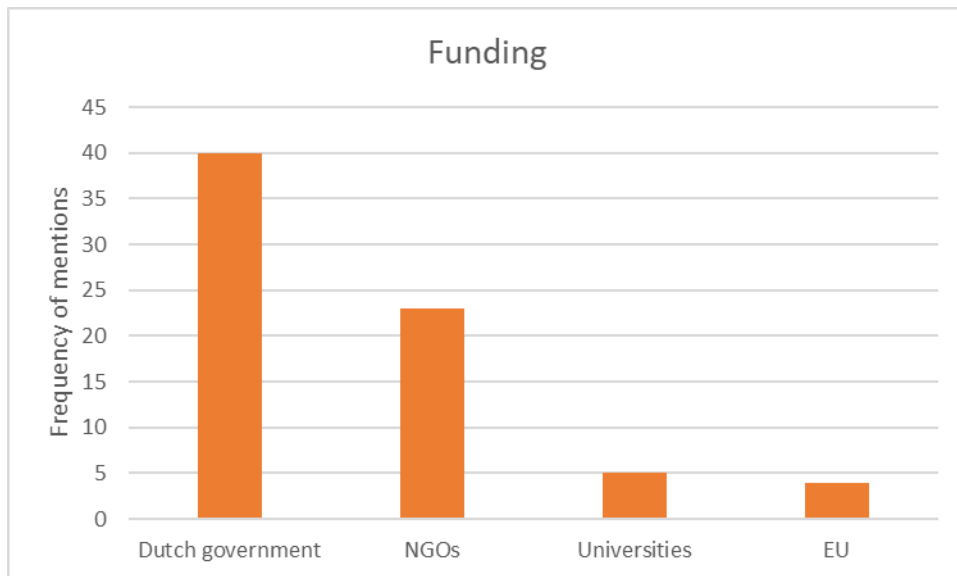


Figure 8: Frequency of mentions of the different potential funders by the interviewees.

To begin with, the overall responsibility for eel conservation of the European eel lies with the Dutch government. The relevant governmental department for this topic is the Ministry of LNV. They have to account their actions to the European Union, as the Dutch eel management plan is part of the broader European Eel regulation from 2007 (Dekker, 2016). As eel recovery measures are part of European legislation, they might play a role in financing projects as well. More specifically, the European Maritime, Fisheries and Aquaculture Fund (EMFAF) might make financial contributions to projects that entail efforts to conserve the eel (European Commission, n.d.). For instance, these consist of restricting human activities that cause eel mortality, combat predators, or measures reducing the negative effects of aquaculture (European Commission, n.d.). Applications for this fund should take place on a projectbased level and not by means of structured funding.

The Waterboards function as localized forms of government but they indicated they are very much bound to the guidelines of more centralised forms of government. If the central government, in the form of LNV, makes more strict regulations on fishing eel the waterboards will have to follow up on these regulations. Should this happen, the waterboards can make a case for request on funding for it as well.

The responsible party for the costs depends of course on who initiates the research. This could be academic research like universities or research institutes when they need assistance during their projects. In that case, they should use their funding to pay the fishers for their work and additional equipment. The same holds when other parties want to do research. For instance, NGOs like RAVON, which are interested in monitoring populations, for which they often need fishers to catch fish and count them or have a conservation related project on which they need assistance from fishers. Governmental bodies like waterboards are legally required to do monitoring like KRW monitoring and “visstandbemonstering”. They will hire fishers to perform these tasks and are therefore responsible to cover the costs. As this is a standard task of the waterboard, they will reserve money for this anyway.

Fishers that make the switch to other species like the Chinese mitten crab and the Louisiana crawfish are already partly being compensated by selling these catches. Invasive species like crayfish and Mitten crabs cause problems in the ecosystems in which they occur. Therefore, fishing those species might contribute to nature conservation and restoration, as it might help in reducing their populations (Hein et al., 2007). Conservation NGOs might thus be interested to co-finance such projects. Moreover,

controlling invasive species might contribute to reaching nature management targets, for example those established for Natura2000 areas or species mentioned on the birds or habitats directives (Lemmers et al., 2018). Following this line of reasoning might reveal new funding sources for this task for eel rangers. Possibly, increasing the fishing for invasive species might be made part of a LIFE project in which certain habitats are restored. Within such a project, funding might become available for new or improved gear and changes in collaboration and legislation to allow fishing for invasives. In that case, the responsibility for the implementation would lie with the provinces, which apply the EU regulations on conservation, and the national Dutch government, which bears the final responsibility for these projects (Sanders et al., 2020; Kuindersma et al., 2020).

During the interview with one of the fishers, it was said that Vattenfall, the owner of the hydro power station in Maurik, was paying the fishers to put the eel over this barrier. Therefore, it might be possible to get funding from companies who own the barriers if they are willing to pay for this. As the DUPAN foundation is responsible for the implementation of these projects, one might think they will also make a financial contribution. However, we have not been able to verify this.

Regarding anti-poaching programmes, the responsible authorities in the Netherlands are the NVWA (Nederlandse Voedsel en warenautoriteit; Dutch Food Safety Authority) and Sportvisserij Nederland.

On their Website the NVWA states that they are mainly engaged in addressing larger scale poaching, whereas Sportvisserij Nederland focuses on smaller-scale poaching with rods or other small-scale eel fishing techniques. They are responsible for control and enforcement of regulations regarding eel fisheries. If eel fishers would become involved, it thus is likely that they will cover the financial costs to be made, possibly supplemented with governmental subsidies.

Other job opportunities, like habitat maintenance can be funded by the waterboards as maintaining the waterways and other water bodies are already part of their regular management tasks.

#### 5.4 Challenges to the transition

The possible tasks of an 'eel ranger' and how they could be financed are now described, but there are still factors that present a challenge to this transition. The transition of being an eel fisher to an 'eel ranger' needs to be profitable for the fishers, otherwise they will not want to make this shift. An 'eel ranger' should therefore make at least as much money as a fisher does now or preferably more, to make it more appealing to the fisher. This is important because the fishers would rather keep their profession than to do other tasks.

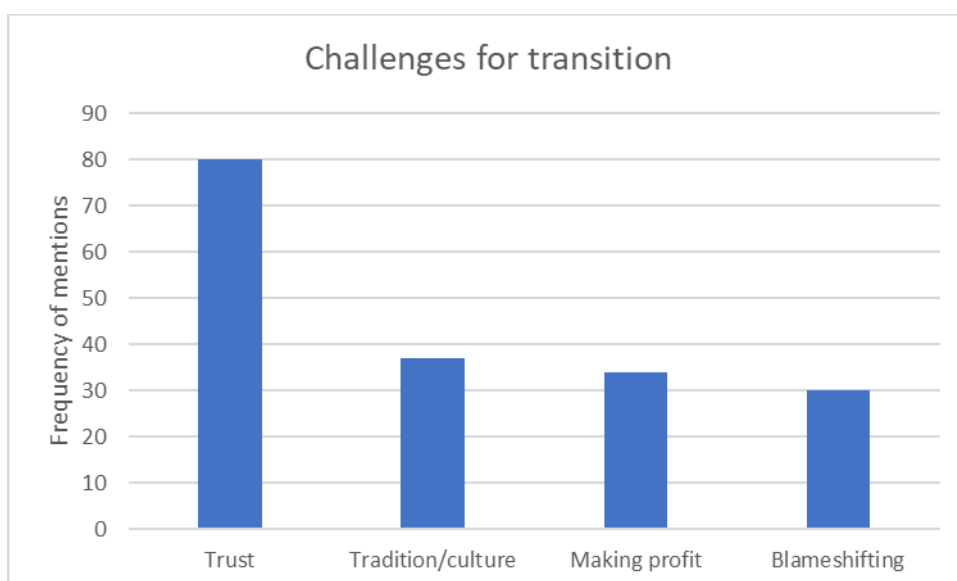


Figure 9: Frequency of mentions of the four codes under 'challenges for transition' coding group across all 13 interviews.

Transitioning might also prove difficult because the fishers themselves do not understand why they should change their profession while the other threats, which they consider to be worse, are not being tackled. They mentioned that the cormorant was a big problem, however a study from van Rijn & van Eerden (2003) showed that at the IJsselmeer, the eel was only 6 % of the diet in November while it was 2 % or even less for the other months. The number of breeding cormorants decreased in 2020 to around 16,250-16,750 breeding pairs, while the maximum number of migrating cormorants lies between 46,100-72,000 individuals (Sovon vogelonderzoek, n.d.). So, even though their diet does not contain a large portion of eel, they still might have an impact. Solving other problems, like the barriers and toxicity, will be a long-term project, which will probably be very costly. Transitioning fishers on the other hand will be more of a short-term action and therefore is being handled currently.

From the interviews it became clear that there was mistrust between fishers and other parties like the governmental bodies and NGOs. Organisations like ICES and Good Fish state that the eel population is declining in Europe, while the fishers do not observe a local decrease in eel landings (fisher 1, 2 and 3; ICES, 2021; FishSec, 2021). This could be due to different perceptions on fluctuations of fish stocks (Verweij et al., 2010). The usage of different parameters and time frames by fishers and scientists make temporal patterns seem different when viewing populations at the local or international level, respectively (Verweij et al., 2010). Furthermore, two fishers told that fishers have helped with research, but that the results of these research project showed different patterns than the ones they observed and collected themselves (Fishers 1,2). For one of the fishers this meant that he does not want to help with research again (Fisher 1) while the other is still willing to help, however he only wants to help when he agrees with the data that is being presented (fisher 2). It also depends on what kind of research they need to help with.

Eel fishing is a traditional craft, which is passed down for generations. This will make it very difficult for the fishers to make the transition to an 'eel ranger' as they might have to do other tasks than fishing. It would be more appealing to the fishers if this shift would be only temporarily: "They don't want to do other stuff. But they might want to do it if they know it's a transition period or it's temporarily" (Academic 4). Besides the fishing itself, eating eel is also seen as part of the tradition: "Yeah, that's tradition to eat eels, but I think your focus should be on eating eels and not on wild harvest alone." (Academic 1). Catching eel for research or conservation purposes, where the fishers must release the eel afterwards will take away this part of the tradition and might make the fishers less tempted to participate in these projects.

Local communities and managers frequently have opposing values and livelihoods which makes conservation efforts rather difficult to achieve. In the Canadian case study, lack of trust between stakeholders was a key topic during the public consultations between the local community and resource managers on managing the wild salmon population in Terra Nova's National Park (Cote et al., 2021). Residents complained that park employees had intentionally lied about salmon abundance in the national park to advance conservationist ideals rather than permit fishing (which was sanctioned within Terra Nova). Since poachers were taking fish that was already unavailable for residents (considered "park fish"), locals were more likely to be apathetic towards illegal fishing. Comanagement was employed through the hiring of local students in monitoring of salmon which addressed and helped in decreasing mistrust of data collection as well as real-time reporting on salmon numbers. This study provides an example on how participation of the local community with resource managers can cooperate based on transparency and knowledge sharing. Fishers might be dissuaded to engage with



science if these interactions result in power restrictions towards fishers (e.g., restricted areas, set quotas).

## 6. Plan

In this chapter we will draw together all data we collected during our study and translate them into practical recommendations on the tasks we suggested for the eel ranger programme. Before we could make a financial overview of the transition to an eel ranger, we first had to define the tasks of said eel ranger. We suggested five different tasks that eel rangers can do: 1) helping in research, 2) combatting eel poaching, 3) help with Eels over the Dykes or glass eel restocking, 4) shifting to fishing invasive species and 5) performing other management tasks. To round off, we will provide advice on the feasibility of these tasks.

To begin with, we found that the minimum net income that fishers should be compensated for is €50 per hour, leading to a minimum net income of €2000. Of course, this is only a rough estimate, as the available data was limited. This estimation holds for the compensation of several of the ranger tasks, from assisting in research projects, to fulfilling other non-fishing jobs, monitoring poaching and helping eels to skip barriers. The waterboards or other landowners need to pay for maintenance tasks already and they could hire local fishers for this.

Table 4: Complete overview of the pros and cons of the eel ranger job alternatives suggested in this report, including a description of likely costs and entities that are most likely responsible for providing said funding.

	Pros	Cons	What needs to be funded	Responsibility (to fund)
Research	<ul style="list-style-type: none"> <li>- Owned equipment by fishers can reduce costs</li> <li>- Surveillance while on the water</li> <li>- Fishers' knowledge might improve research</li> <li>- More knowledge on eel populations</li> <li>- Improved relations and agreement between fishers and researchers</li> </ul>	<ul style="list-style-type: none"> <li>- Cannot be done all year - May not be sustained for many years</li> <li>- Observers from external parties needed</li> <li>- Hard to make it a full-time job</li> <li>- In its current state a fragile relationship between fishers and scientists</li> </ul>	<ul style="list-style-type: none"> <li>- Compensation for time spent by fishers (€50/hour/fisher)</li> <li>- potentially some equipment</li> <li>- External observers may need compensation too</li> </ul>	<ul style="list-style-type: none"> <li>- Research initiators: Government</li> <li>- NGOs</li> <li>- Academia</li> <li>- Research instances</li> <li>- EU funding</li> </ul>
Eels over the Dykes, restocking	<ul style="list-style-type: none"> <li>- Fishers can apply fishing skills</li> <li>- Already done by fishers</li> <li>- Fishers already have equipment</li> <li>- Less turbine deaths</li> <li>- More eels get to sea</li> </ul>	<ul style="list-style-type: none"> <li>- Temporary fix (Eels over the Dykes) or effectiveness is not proven (restocking)</li> <li>- Hard to make it a fulltime job</li> </ul>	<ul style="list-style-type: none"> <li>- Compensation for time spent by fishers (€50/hour/fisher)</li> </ul>	<ul style="list-style-type: none"> <li>- Government: Waterboards</li> <li>- LNV</li> <li>- Barrier owners</li> </ul>

Alternative fishing	<ul style="list-style-type: none"> <li>- Plenty of specimens to catch</li> <li>- Invasive species are reduced in number, benefitting native ecosystems</li> <li>- Income from fishing</li> <li>- Less eels are removed</li> </ul>	<ul style="list-style-type: none"> <li>- Legislative changes needed</li> <li>- Less profit than eel fishing unless changes are made</li> <li>- Hard to make it a fulltime job in its current state</li> <li>- Eel fishing culture is (temporarily) lost</li> <li>- Due to similar gear, needs special permit</li> <li>- Ecological considerations needed to truly lead to positive ecological effects</li> </ul>	<ul style="list-style-type: none"> <li>- Alternative fishing gear</li> <li>- Removal of invasive species</li> </ul>	<ul style="list-style-type: none"> <li>- LNV</li> <li>- EU might fund removal of invasive species</li> <li>- Provinces</li> </ul>	
Anti-poaching	<ul style="list-style-type: none"> <li>- Surveillance while on the water</li> <li>- Active protection of eel</li> <li>- Less eels are removed</li> </ul>	<ul style="list-style-type: none"> <li>- Education is needed</li> <li>- Authority lies with police</li> <li>- Eel fishing culture is (temporarily) lost</li> <li>- No existing fish ranger plan, no defined set of tasks or responsibilities</li> <li>- Might increase rivalry between fishers</li> </ul>	<ul style="list-style-type: none"> <li>- Education programme</li> <li>- Compensation for time spent by fishers (€50/hour/fisher)</li> </ul>	<ul style="list-style-type: none"> <li>- NVWA – central government (for largescale poaching)</li> <li>- Sportvisserij Nederland (for small-scale poaching)</li> </ul>	
Non-fishing alternatives	Water quality monitoring (KRW)	<ul style="list-style-type: none"> <li>- Feasible for fishers</li> <li>- Fishers contribute to healthy environments for fish</li> <li>- Surveillance while on the water</li> <li>- Better relationships with 'own fishers' than with external agencies</li> </ul>	<ul style="list-style-type: none"> <li>- Not done throughout the whole year</li> <li>- Sometimes proper guidance is needed by KRW</li> <li>- May not be feasible for all fishers in one area to do this</li> </ul>	<ul style="list-style-type: none"> <li>- Compensation for time spent by fishers (€50/hour/fisher)</li> <li>- Some equipment</li> </ul>	Waterboards
	Area maintenance	<ul style="list-style-type: none"> <li>- Diverse set of tasks that are done all year</li> <li>- Eels benefit from healthier areas</li> </ul>	<ul style="list-style-type: none"> <li>- Not every fisher is capable of this.</li> <li>- Fishers need to be flexible</li> </ul>	<ul style="list-style-type: none"> <li>- Compensation for time spent by fishers (€50/hour/fisher)</li> </ul>	<ul style="list-style-type: none"> <li>Owners of the area: Waterboards</li> <li>Municipalities</li> <li>Nature organizations</li> </ul>
		<ul style="list-style-type: none"> <li>- Fishers possess the knowledge, skills and equipment</li> <li>- Surveillance while on the water</li> <li>- Better relationships with local fisher than with external agencies</li> </ul>	<ul style="list-style-type: none"> <li>- May not be feasible for all fishers in one area to do this (not enough work for all)</li> </ul>	<ul style="list-style-type: none"> <li>- Some equipment</li> </ul>	Rijkswaterstaat
	Consultancy	<ul style="list-style-type: none"> <li>- Fishers often have extensive knowledge on topics such as fishing etc.</li> <li>- Better relationships with 'own fishers' than with external agencies</li> </ul>	<ul style="list-style-type: none"> <li>- Not every fisher is capable of this.</li> <li>- Less eyes on water looking for illegal activities</li> </ul>	<ul style="list-style-type: none"> <li>- Depends on consultancy costs of the fisher, ranges from €25-75 an hour</li> </ul>	<ul style="list-style-type: none"> <li>Any external company that needs consultancy: Waterboards, Central government, Research institutes</li> </ul>

Additionally, we found out that almost all of these jobs are bound to specific seasons. Fishing for or doing research on specific species obviously only takes place in specific parts of the year, as does the eel migration and doing other specific management tasks. Therefore, it seems hard to sustain the livelihood of an 'Eel ranger' by just one job. We therefore advise to set up a programme in which fishers can, if they want to, combine different tasks. Of course, many fishers do not rely completely on eel fishing, as they also fish for other species. However, for many of them, eel fishing is a substantial part of their income. Therefore, they do not need their year-round income to come from these alternative jobs.

## 7. Recommendations

In this report, we described a possible way of what an eel ranger programme could look like and what is needed to put it in practice. However, during our project, we came across several other important topics, which we would like to address in this final chapter, to round off our advice.

Throughout this report, we are continuously writing about 'fishers'. However, through several sources and interviews, we became aware of the fact that one should be careful with generalising this group as a whole (e.g. Kuijs, 2020). In fact, this is a very diverse group, with many different ideas and opinions. At first there is the clear distinction between the inland fishers and the fishers from the IJsselmeer and Markermeer (waterboard 2). Also, individual fishers can differ strongly in their opinions on, for instance, collaboration with conservation NGOs (NGO 1) and in their specific areas of expertise (waterboard 1). It is important to keep these differences in mind and prevent viewing the fishers as one homogenous group.

Trust turned out to be one of the main topics that appeared in our interviews. We learned that the eel fishing case of the Netherlands is one full of mistrust: there seems to be little communication between the different stakeholders. Often this scarce dialogue does not lead to any clear conclusions, resulting in disagreements in vital topics, such as the eel population trend (fishers 1, 2 and 3; NGO 1; academics 3 and 4). It was made clear by several interviewees that without trust, efforts for eel conservation could be futile (academics 3 and 4), as it also shown in literature. For instance, the Spanish case shows how not involving fishers in the decision-making process led to illegal fishing, protests, and no solutions. However, once they were involved, collaboration based in trust was built, involving all stakeholders. Young et al (2016) also showed that increasing trust among stakeholders makes conflict resolution more likely in conservation conflicts. A main aspect to keep in mind is that locals should be involved in the conservation projects, for this can benefit the process, as seen in the Canada case study. Literature also shows the importance of including local people in conservation efforts, as doing so is linked to successful conservation operations (Persha et al, 2011). Therefore we, as a team, would like to remark that a foundation of trust is crucial for future projects of Good Fish, and that effort should be put in that direction.

During the time we had we were not able to go into all the topics we listed as important. An alternative we were not able to dive into was tourism and education. In one of our interviews, we were told about shrimp fishers on Texel that made a (partial) transition from fishing shrimp to tourism (academic 2). We thought this was a good alternative to explore and see if some eel fishers could potentially do something similar. The shrimp fishers did not, however, respond to our emails but this is still an alternative that should be explored in the future. In terms of legislative power and responsibilities, a lot of our searches ended with the government instances of LNV and NVWA. Since we did not manage to talk to them, in further research these parties should definitely be contacted to answer the remaining questions.

Finally, we would like to make a remark on the possibility that, due to the critical population status of the European eel, national and/or European governments might establish an overall ban on eel fishing. If this would happen, the eel ranger programme might play an important role, as it prevents eel fishers from losing their livelihood and survive the period in which they would not be able to fish. Additionally, if monetary reparations are required, the example of the Ireland study case depicts compensations for fishers when the national-wide ban took place (for further details see Appendix III, Figure 15). Ideally with a good ranger programme, eel fishers will be able to survive despite reducing fishing and maintain their knowledge and culture. In this way, there are possibilities to preserve both the eel and the culture, traditions and livelihoods of the fishers.

## References

- Bark, A., Williams, B., & Knights, B. (2007). Current status and temporal trends in stocks of European eel in England and Wales. *ICES Journal of Marine Science*, 64(7), 1368-1378.
- Berkes, F. 2012. *Sacred ecology: traditional ecological knowledge and resource management*. London: Taylor and Francis.
- Bestuur-DUPAN (2022). In *DUPAN*
- Bevacqua, D., Melià, P., Gatto, M., & De Leo, G. A. (2015). A global viability assessment of the European eel. *Global Change Biology*, 21(9), 3323-3335.
- Bryhn, A., Sapoundis, A., Svagzdys, A., Taylor, A., El Ganainy, A., Fernández-Delgado, C., ... & Dekker, W. (2021). Joint EIFAAC/ICES/GFCM Working Group on Eels (WGEEL).
- Campbell, L. M., Silver, J. J., Gray, N. J., Ranger, S., Broderick, A., Fisher, T., ... & Godley, B. (2009). Comanagement of sea turtle fisheries: Biogeography versus geopolitics. *Marine Policy*, 33(1), 137-145.
- Clark, P. F., Mortimer, D. N., Law, R. J., Averno, J. M., Cohen, B. A., Wood, D., ... & Rainbow, P. S. (2009). Dioxin and PCB contamination in Chinese mitten crabs: human consumption as a control mechanism for an invasive species. *Environmental science & technology*, 43(5), 1624-1629.
- Cote, D., Van Leeuwen, T. E., Bath, A. J., Gonzales, E. K., & Cote, A. L. (2021). Social–ecological management results in sustained recovery of an imperiled salmon population. *Restoration Ecology*, 29(5), e13401.
- Dekker, W. (2003). Status of the European eel stock and fisheries. In *Eel biology* (pp. 237-254). Springer, Tokyo.
- Dekker, W. (2016). Management of the eel is slipping through our hands! Distribute control and orchestrate national protection. *ICES Journal of marine science*, 73(10), pp. 2442-2452.
- Drouineau, H., Durif, C., Castonguay, M., Mateo, M., Rochard, E., Verreault, G., ... & Lambert, P. (2018). Freshwater eels: A symbol of the effects of global change. *Fish and Fisheries*, 19(5), 903-930.
- DUPAN (n.d.). Contact. Retrieved at 21-10-2022 at <https://dupan.nl/contact/>
- Dutta, A. (2020). The conservation-corruption conundrum: understanding everyday relationships between rangers and communities. *U4 publications*. <https://www.u4.no/publications/theconservation-corruption-conundrum-understanding-everyday-relationships-between-rangers-andcommunities>. Accessed on October, 11, 2022.

European Commission (n.d.). *Eel*. Retrieved at 20-10-2022 at [https://oceans-andfisheries.ec.europa.eu/ocean/marine-biodiversity/eel\\_en](https://oceans-andfisheries.ec.europa.eu/ocean/marine-biodiversity/eel_en)

European Commission, Directorate-General for Maritime Affairs and Fisheries, *Smoked eel in the EU : price structure in the supply chain focus on the Netherlands, Germany and Denmark, January 2021*, Publications Office, 2021, <https://data.europa.eu/doi/10.2771/2362>

European Commission, Directorate-General for Maritime Affairs and Fisheries, MacNab, S., Luchetta, G., Nimmo, F. (2020). Evaluation of the Eel Regulation: final report, Publications Office. <https://data.europa.eu/doi/10.2771/679816>

Eels shipped by air found in operation Lake-V. (2021, June 4). In *Europol*. <https://www.europol.europa.eu/media-press/newsroom/news/eels-shipped-air-found-in-operationlake-v>

Feunteun, E. (2002). Management and restoration of European eel population (*Anguilla anguilla*): an impossible bargain. *Ecological engineering*, 18(5), 575-591.

Garrido, F. E., Ruiz-Ruiz, J., Lafuente-Fernández, R., & Villafuerte, R. (2020). Exploring perceptions to manage conflicts: The case of the European eel fishing moratorium in Southern Spain. *Human Dimensions of Wildlife*, 25(2), 136-153.

Geeraerts, C. & Belpaire, C. (2010). The effects of contaminants in European eel: a review. *Ecotoxicology*, 19(2), 239-266.

Gherardi, F., Aquiloni, L., Diéguez-Urbeondo, J., & Tricarico, E. (2011). Managing invasive crayfish: is there a hope?. *Aquatic Sciences*, 73(2), 185-200.

Good Fish Foundation (2019). *Kennisplatform rivierkreeft symposiumboek* [report]. Veenendaal: Good Fish Foundation

Granek, E. F., Madin, E. M., Brown, M. A., Figueira, W., Cameron, D. S., Hogan, Z., ... & Arlinghaus, R. (2008). Engaging recreational fishers in management and conservation: global case studies. *Conservation Biology*, 22(5), 1125-1134.

Griffioen, A.B., van Keeken, O. A. (2021). *Verspreiding en uittrekperiode van schieraal rondom sluizencomplex IJmuiden* [research report]. IJmuiden: Wageningen Marine Research.

Haggan, N., Neis, B., & Baird, I. G. (Eds.). (2007). *Fishers' knowledge in fisheries science and management*.

Hein, C. L., Vanderzanden, M. J., Magnuson, J.J. (2007). Intensive trapping and increased fish predation cause massive population decline of an invasive crayfish. *Freshwater biology*, 52(6), pp. 1134-1146.

Heinsbroek, L. T. N. (1991). A review of eel culture in Japan and Europe. *Aquaculture Research*, 22(1), 57-72.

Hennessy, M. (2018, March 25). *Eel fishermen who went out of business after Irish Ban May soon receive financial support*. TheJournal.ie. Retrieved October 21, 2022, from <https://www.thejournal.ie/eel-fishers-3915488-Mar2018/>

Hoogenboom, R. L., Kotterman, M. J., Hoek-van Nieuwenhuizen, M., van der Lee, M. K., Mennes, W. C., Jeurissen, S. M., & van Leeuwen, S. P. (2015). Dioxins, PCBs and heavy metals in Chinese mitten crabs from Dutch rivers and lakes. *Chemosphere*, 123, 1-8.

International Council for the Exploration of the Sea (ICES). 2017. European eel (*Anguilla anguilla*) throughout its natural range. ICES Advice ele.2737.nea. ICES, Copenhagen, Denmark. [online] URL: <http://doi.org/10.17895/ices.pub.3440>

ICES. 2018. European eel (*Anguilla anguilla*) throughout its natural range. In Report of the ICES Advisory Committee, 2018. ICES Advice 2018, ele.2737.nea. <https://doi.org/10.17895/ices.pub.4601> ICES, . (2020). European eel (*Anguilla anguilla*) throughout its natural range (Version 1). ICES Advice: Recurrent Advice. <https://doi.org/10.17895/ices.advice.5898>

ICES. 2019. European eel (*Anguilla anguilla*) throughout its natural range. In Report of the ICES Advisory Committee, 2019. ICES Advice 2019, ele.2737.nea. <https://doi.org/10.17895/ices.advice.4825>

ICES. 2020. European eel (*Anguilla anguilla*) throughout its natural range. In Report of the ICES Advisory Committee, 2020. ICES Advice 2020, ele.2737.nea. <https://doi.org/10.17895/ices.advice.5898>

ICES. 2021. European eel (*Anguilla anguilla*) throughout its natural range. In Report of the ICES Advisory Committee, 2021. ICES Advice 2021, ele.2737.nea. <https://doi.org/10.17895/ices.advice.7752>

IJongbloed, R. H., van Hoppe, M., van Hal, R. (2017). *Bijvangst door innovatieve visserijmethoden voor wolhandkrab op het IJsselmeer* [research report]. Wageningen: Wageningen Marine research.

*Jouw Gids voor Goede vis!* VISwijzer. (2022, October 17). Retrieved October 19, 2022, from <https://www.goodfish.nl/>

Knights, B., Bark, T., & Williams, B. (2006). A review of the status of European eel stocks in north west Europe. In *ICES Annual Science Conference CM*.

Kuindersma, W, de Wit-de Vries, E., Boonstra, F.G., Pleijte, M., Kamphorst, D.A. (2020). *Het Nederlandse natuurbeleid in zijn institutionele context, Beschrijving en analyse van de interne en externe congruentie van het nederlandse natuurbeleidsarrangement in relatie tot landbouwbeleid, waterbeleid (voor de grote rivieren) en recreatiebeleid (1975-2018)* [Research report]. Wageningen: Wageningen University & Research

Kuiper, T., Massé, F., Ngwenya, N. A., Kavhu, B., Mandisodza-Chikerema, R. L., & Milner-Gulland, E. J. (2021). Ranger perceptions of, and engagement with, monitoring of elephant poaching. *People and Nature*, 3(1), 148-161.

Kuijs, E.K.M. (2020). *Listening to eel fishermen: a livelihood perspective on the effectiveness of the eel ban withing the Dutch eel management plan* [Msc thesis]: Wageningen: Wageningen University & Research.

Kumar, R. (2019). *Research methodology: a step-by-step guide for beginners* (Fifth). SAGE.

Lemmers, P., Crombaghs, B.H.J.M., Leuven, R.S.E.W (2018). *Invasieve exotische kreeften in het beheergebied van waterschap Rivierenland, verkenning van effecten, risico's en mogelijke aanpak* [Professional report]. Nijmegen: Natuurbalans-Limes divergens B.V.

Lemmers, P., Crombaghs, B. H. J. M., & Leuven, R. S. E. W. (2018). *Invasieve exotische kreeften in het beheergebied van waterschap Rivierenland: verkenning van effecten, risico's en mogelijke aanpak*. Natuurbalans-Limes Divergens.

Lloret, J., Cowx, I. G., Cabral, H., Castro, M., Font, T., Gonçalves, J. M., ... & Erzini, K. (2018). Small-scale coastal fisheries in European Seas are not what they were: ecological, social and economic changes. *Marine Policy*, 98, 176-186.

- Moorhouse, T. P., & MacDonald, D. W. (2010). Immigration rates of signal crayfish (*Pacifastacus leniusculus*) in response to manual control measures. *Freshwater Biology*, 56(5).
- Moriarty, C., & Dekker, W. (1997). *Management of the European eel*. Marine Institute.
- Over raven. RAVON. (n.d.). Retrieved October 19, 2022, from <https://www.ravon.nl/OverRAVON/Organisatie>
- Natural recruitment of depleted european eel is finally increasing. (2019, November 8). In *Sustainable Eel Group*. <https://www.sustainableeelgroup.org/natural-recruitment-of-depleted-european-eel-isfinally-increasing/>
- NeVeVi (2021). Kenmerken van de sector. Retrieved at 21-10-2022. <https://www.nevevi.nl/kenmerken-van-de-sector/>
- Persha, L., Agrawal, A., & Chhatre, A. (2011). Social and ecological synergy: local rulemaking, forest livelihoods, and biodiversity conservation. *science*, 331(6024), 1606-1608.
- Prins, H., & Zaalmink, W. (2015). Decentralized eel management in Friesland: an economic analysis. *Decentralized eel management in Friesland: an economic analysis*.
- Projectgroep Beheerplan. (2021). Beheerplan Watersysteem [slideshow], the Netherlands
- Pujolar, J. M., Jacobsen, M. W., Als, T. D., Frydenberg, J., Munch, K., Jónsson, B., ... & Hansen, M. M. (2014). Genome-wide single-generation signatures of local selection in the panmictic European eel. *Molecular Ecology*, 23(10), 2514-2528.
- Quak, J. (2011). De aal: portret van een uistervende globetrotter. *RAVON*, 13(1), 1-6.
- Rice, J. (2016, March 29). *IFI launches scientific fisheries for Eel*. Angling Council of Ireland. Retrieved October 21, 2022, from <https://www.anglingcouncil.ie/ifi-launches-scientific-fisheries-for-eel-aroundireland/>
- Sanders, M., Bredenoord, H., Kok, M., van Oorschot, M. (2020). *Nederlands natuurbeleid in internationale context, voortgang realisatie natuur- en biodiversiteitsbeleid* [Professional report]. Den Haag: Planbureau voor de leefomgeving.
- Schollemma P.P., Waterschap Hunze & Scheper, A.J. (30 december 2013). Vismigratie van Aa tot Zee. *Visionair*, 20-23
- Sovon vogelonderzoek (n.d.). Aalscholver. Accessed on 19 October 2022, of <https://stats.sovon.nl/stats/soort/720>
- Sporrong N. & Castro E. T. (2021). Annual three-month eel fishing closures – do they protect migrating eels in the EU?. The Fisheries Secretariat (FishSec). <https://www.fishsec.org/app/uploads/2021/06/FishSec-eel-closures-report-2021-final.pdf>
- Tesch, F. W., & Bartsch, P. (2003). *The eel* (p. 408). Oxford: Blackwell science.
- van den Thillart, G. E. (2014). European Eels: Dutch Fisheries, Culture and Eel Migration. In *Eels and Humans* (pp. 61-74). Springer, Tokyo.
- van der Hammen, T. (2018). *Evaluation of glass eel and ongrown eel restocking practices in The Netherlands*. Wageningen Marine Research.

**Van ginneken & Maes, 2005:** The European eel (*Anguilla anguilla*, Linnaeus), its Lifecycle, Evolution and Reproduction: A Literature Review

van Keeken, O. A., van Hal, R., Volken Winter, H., Tulp, I., & Griffioen, A. B. (2020). Behavioural responses of eel (*Anguilla anguilla*) approaching a large pumping station with trash rack using an acoustic camera (DIDSON). *Fisheries Management and Ecology*, 27(5), 464-471.

Van Rijn, S., & Van Eerden, M. (2003). Cormorants in the IJsselmeer area: Competitor or indicator. *Cormorant Research Group Bulletin*, 5, 31-32.

van Uhm, D. P., & Moreto, W. D. (2018). Corruption within the illegal wildlife trade: a symbiotic and antithetical enterprise. *The British Journal of Criminology*, 58(4), 864-885.

van Walraven, L.. (2016). De status van de Europese aal in Nederland: is het broodje paling al duurzaam?. *RAVON*, 18(3), 58–59.

*Verlenging registratie als beroepsvisser.* (March 2022). RVO.nl. Retrieved 20 October 2022, from <https://www.rvo.nl/onderwerpen/verlenging-registratie-als-beroepsvisser>

Verweij, M. C., Van Densen, W. L. T., & Mol, A. J. P. (2010). The tower of Babel: different perceptions and controversies on change and status of North Sea fish stocks in multi-stakeholder settings. *Marine Policy*, 34(3), 522-533.

Wright, R.M., Piper, A.T., Aarestrup, K. et al. First direct evidence of adult European eels migrating to their breeding place in the Sargasso Sea. *Sci Rep* 12, 15362 (2022). <https://doi.org/10.1038/s41598022-19248-8>

Young, J. C., Searle, K., Butler, A., Simmons, P., Watt, A. D., & Jordan, A. (2016). The role of trust in the resolution of conservation conflicts. *Biological Conservation*, 195, 196-202.

Zaalmink, W., Rijk, P. (2018). *Vangsten, handel en consumptie van wolhandkrab in Nederland* [research report]. Wageningen: Wageningen Economic Research.

## Appendices

### Appendix 1: Code groupS

Table 5. Code group titles and all the codes that they include

Code Group Title	Codes
<i>Eel ranger tasks</i>	<ul style="list-style-type: none"> <li>- Anti-poaching</li> <li>- Research (includes tagging, tracking, measuring, monitoring mortality)</li> <li>- Tourism</li> <li>- Education</li> <li>- Alternative fishing (includes invasive species and other species)</li> <li>- Moving eel (includes restocking and “Eels over the Dykes” Project) - Non-fishing alternatives</li> </ul>



<i>Funding sources</i>	<ul style="list-style-type: none"> <li>- EU</li> <li>- Universities</li> <li>- NGOs (includes WWF, postcode lottery) - Dutch government (includes LNV, waterboards, Rijkswaterstaat)</li> </ul>
<i>Challenges to transition</i>	<ul style="list-style-type: none"> <li>- Making profit</li> <li>- Blame shifting</li> <li>- Trust</li> <li>- Tradition/culture (fishing, eating)</li> <li>- Capacity</li> </ul>
<i>Outside topics</i>	<ul style="list-style-type: none"> <li>- Toxicity</li> <li>- Label</li> <li>- Secondary jobs</li> <li>- Recreational fisheries</li> <li>- Poaching (when mentioned as an issue, not as a ranger opportunity)</li> <li>- Aquaculture</li> <li>- Barriers</li> <li>- Eel reserves</li> </ul>

## Appendix 2: Graphs with codes

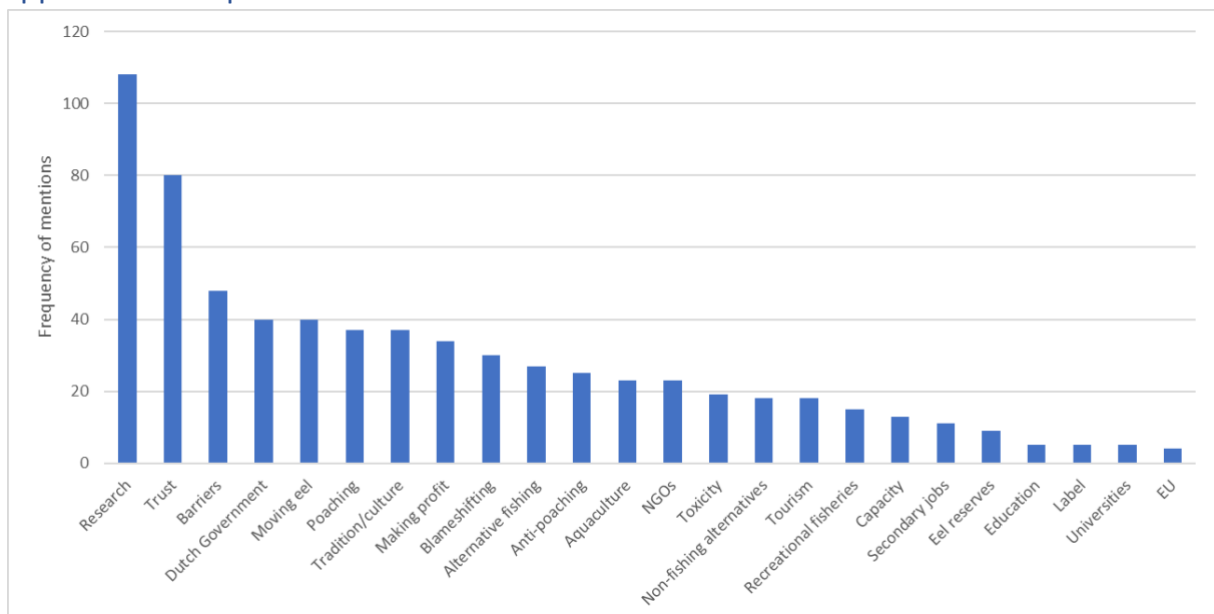


Figure 10. Frequency of all codes mentioned by all interviewees

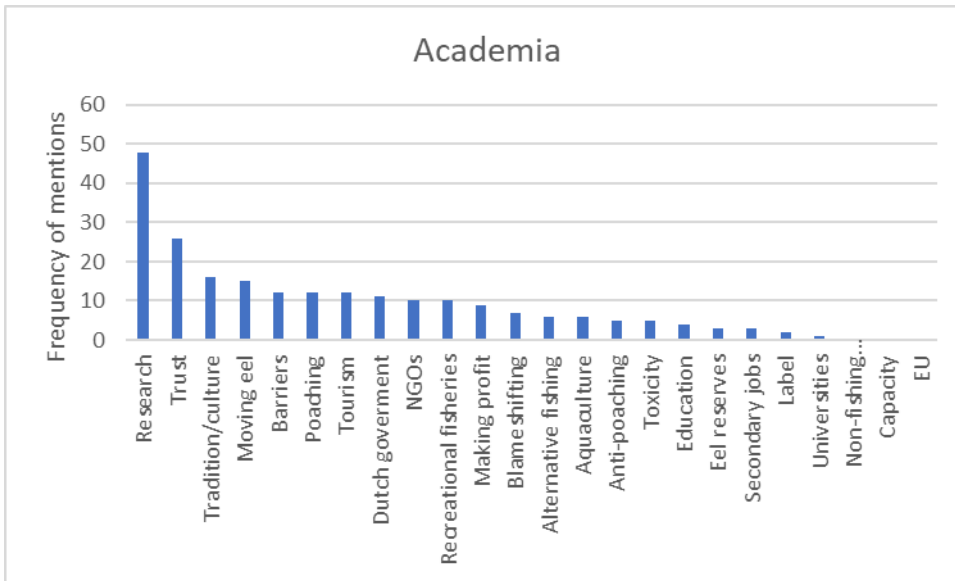


figure 11.

Graph showing the frequency of all codes mentioned by academics in the interviews

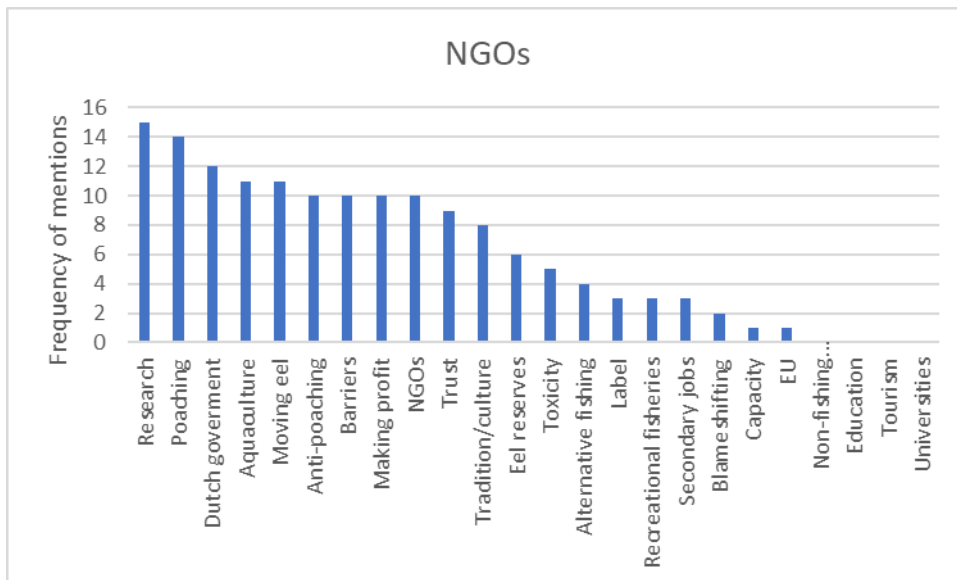


Figure 12. Graph showing the frequency of all codes were mentioned by NGOs in the interviews

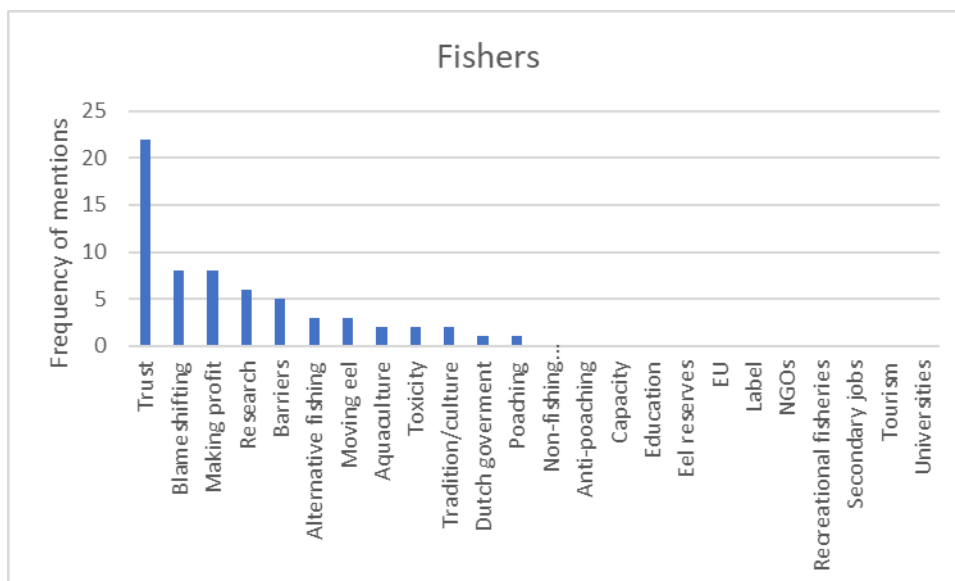


Figure 13. Graph showing the frequency of all codes were mentioned by fishers in the interviews

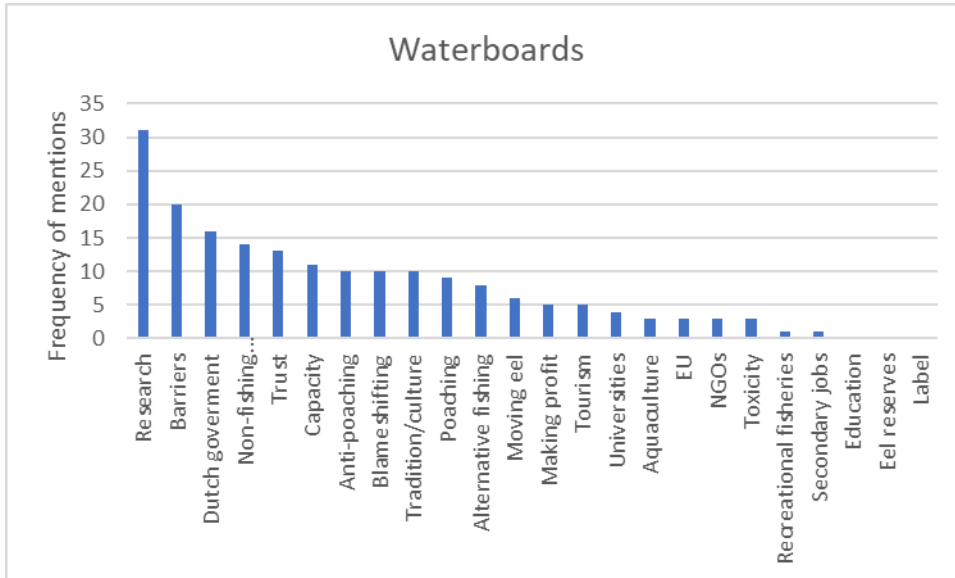


Figure 14. Graph showing the frequency of all codes were mentioned by academics in the interviews

### Appendix 3:

Table 5. Breakdown of costs of maintenance according to width and length of waterways.

Costs maintaining waterway	width of waterway	€ per meter	€ per 500 meters
Mowing whole profile	< 6 meters	0.33	165
	> 6 meters	0.44	220
Mowing profile partially	< 6 meters	0.28	140
	> 6 meters	0.44	220
Mowing sediment	< 6 meters	0.22	110
	> 6 meters	0.3	150

Bands of payments for average catch over years fished in the datum years

Band	Average Declared Catch 2003 - 2007	Band lower Kg.	Band Upper Kg.	Amount of payment based on Average catch declared to IFI or the ESB by fisherpersons.
Band 1	No Catch	0	0	€0
Band 2	Average declared catch of between 1 kg- 50 kg for years they held licence or permit	1 kg	50 kg	€1,000
Band 3	Average declared catch of between 51 kg- 150 kg for years they held licence or permit	51 kg	150 kg	€1,500
Band 4	Average declared catch of between 151 kg- 300 kg for years they held licence or permit	151 kg	300 kg	€3,000
Band 5	Average declared catch of between 301 kg- 650 kg for years they held licence or permit	301 kg	650 kg	€6,000
Band 6	Average declared catch of between 651 kg- 1,000 kg for years they held licence or permit	651 kg	1,000 kg	€10,000
Band 7	Average declared catch of between 1,001 kg- 1,500kg for years they held licence or permit	1,001 kg	1,500 kg	€13,000
Band 8	Average declared catch of between 1,501 kg- 2,000 kg for years they held licence or permit	1,501 kg	2,000 kg	€16,000
Band 9	Average declared catch of between 2,001 kg- 4,000 kg for years they held licence or permit	2,001 kg	4,000 kg	€21,000
Band 10	Average declared catch of over 4,001 kg for years they held licence or permit	4,001 kg	No limit	€23,000

Figure 15. Economic compensation provided by the Irish government to eel fishers following the complete ban on eel fishing in 2009. Source: Eel Fisherpersons Support Scheme Booklet & Application Form, page 8, Inland Fisheries Ireland.