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One, two, three, many! or…? Mapping of the controversy over the Swedish West Coast shrimp

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Abstract

'Controversy mapping' can provide insights about issues related to actors, their networking, and governance where the interpretation of science is at stake. In turn, these insights can be useful for advocacy processes and collective problem-solving. In order to illustrate this statement a case study was conducted for the North Sea prawn (Pandalus borealis) in the West Coast of Sweden which was the main subject of a controversy that started in 2014 and ended in October 2015 with a Marine Stewardship Council labeling for the contested prawn. We used a method from the scientific humanities, 'controversy mapping', following the methodology suggested by Venturini (2010) and Latour (2012). The method enabled us to trace statements, literatures, and actors involved in the shrimp controversy. By assembling these elements over time, we were able to describe the process of the controversy and identify the networks that 'wrestled' over the scientific interpretation of the (same) data on shrimp population size along the Swedish West Coast. By using network visualisation and analysis software, the case study shows the extension of the network of actors that were part of the controversy, their roles, influence, perspectives and relationships. The material gathered on the controversy was subsequently analysed from the perspective of the production and consumption system of the shrimp. It shows how advocacy actors build alliances with selected product chain actors in order to gather momentum for change. Based on the findings from this research it is possible to suggest that controversy study can help the product chain actors understand their production and consumption system better and provide a basis for product chain roundtables for conflict resolution and problem solving.

Keywords: ecolabelling, wildlife, controversy, pandalus borealis, Sweden

1. Introduction – the shrimp controversy as it evolved

In February 2014, news about the local shrimps made unsettling reading in the newspapers in Gothenburg and other cities on the Swedish West coast. It made waves also into national news. The West coast shrimp, elsewhere known as the deep-sea prawn (Pandalus borealis), fished in the Skagerrak, Kattegat and the Atlantic, had received a ‘red light’ in the 2014 edition of the WWF Sweden consumer fish guide. Opinions multiplied and propagated through the news, on blogs, twitter, etc.

To understand the agitation, one needs to know that people in Gothenburg and on the Swedish West coast take their seafood very seriously. Shrimp sandwiches and shrimp binging (‘räkfrossa’) are iconic examples of local food culture. Gothenburg is sometimes referred to as the *city of the shrimp*. What is special about the local shrimp is that it is wild-caught, usually at night, and cooked on board in salty water to be sold on the market in the morning. Unsold shrimps at the end of the day become ingredient for cooking and salads.

WWF's arguments for the warning were presented in the media, not only by the person responsible for marine and fishing issues, but also by the organization's director and other officials. The arguments for the red light included the halving of the shrimp stock in the last 5 years, weak management and inadequate controlling, according to Håkan Wirtén, director of WWF Sweden (Göteborg Posten, 2014).

Later that year, other events increased the controversy. For example, in June the control authority was able to catch on film a vessel illegally dumping shrimp in the middle of the sea, one of the practices WWF highlighted as justifying the red-lighting. This measure was the result of a new control strategy that had been issued by the Swedish Agency for Marine and Water Management (Havs- och Vattenmyndigheten, HaV) and the Coast guard (Kustbevakningen), partly in response to the issues raised by WWF (Havs- och Vattenmyndigheten & Kustbevakningen, 2014). Despite these efforts to improve fishery management, WWF again red-lighted the shrimp in the 2015 version of their consumer guide.

In April 2015, a new announcement, this time coming from the academic institution affiliated to the international conservation organization, the International Union for the Conservation of Nature (IUCN), added a new element to the discussion. Artdatabanken, the Swedish institutional node of IUCN 'red-listed' the Pandalus borealis under the category 'Near Threatened', although it could have been classified as 'Vulnerable' given the reduction in the biomass since 2005 according to their report. However, the seasonal cycles of the shrimps led Artdatabanken to stay with 'Near Threatened' for the time being. This classification was based on an analysis of the biomass of the stock between 2005 and 2014 showing a decrease around 30-50% (Artdatabanken 2015). This apparently supported WWF's warnings in 2014 and 2015.

However, those opposing the consumer guide classification claimed the concerns by WWF were not real since the European Commission, through the International Council for the Exploration of the Sea (ICES), had increased the 'Total Allowable Catch' (TAC) for the Pandalus borealis in the areas corresponding to the Skagerrak and Kattegat fisheries in 2013 (Søvik & Thangstad 2013). The ICES is an organization providing yearly advice to the European Commission authority on fishing regarding the amount of catch to be allowed for different species. Their advice is based on input from different working groups composed of scientists from different countries and organizations. In 2014 and 2015, the ICES advice on total allowable catch for Pandalus borealis in the West Coast waters increased significantly from 6000 tons max. in 2014, to 10.900 tons in 2015 and 21.500 tons in 2016 (ICES 2013, 2014, 2015). These numbers were used by those opposing WWF warnings to contradict them in the press.

However, in November 2015, the local shrimp was 'ecolabelled'. The Marine Stewardship Council and the Gothenburg's Fish Auction announced that the Skagerrak, Kattegat and the Norwegian Deep fisheries for Pandalus borealis were now certified under the Marine Stewardship Council principles and criteria for sustainable fishing under its version 1.1 (DNV-GL 2015). Both the red light and the redlist were still in effect, so, this certification was awarded under specific observation to be reviewed in 2016.

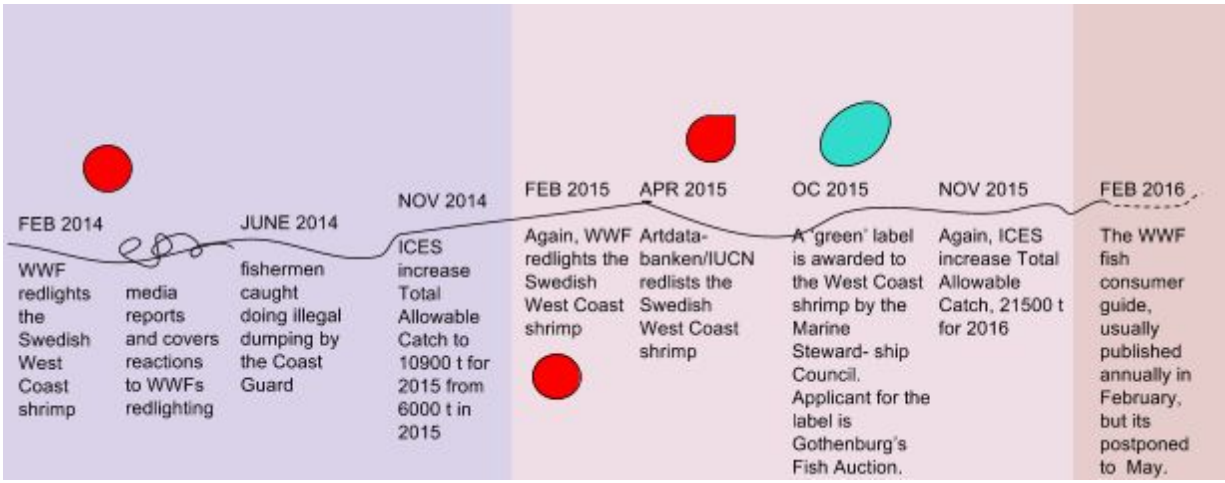

Figure 1. Timeline of the controversy.

1.1. Our aim

The complexity around sustainability issues is worth studying in their entirety — the series of events, the many different positions, the tensions between different actors, their respective approaches and understandings evidence this complexity. Our primary motive is the exploratory testing of Actor-Network-Theory and its tools for mapping controversies since these provide the means for comprehensive descriptions of sustainability problems in society without reducing them to simplicity. A second reason is an exploration of the extent to which the tools and concepts of our home discipline, Industrial Ecology and Environmental Systems Analysis, are relevant to a controversy. We imagined that, for example, there could be references to Life Cycle Assessment, which is often used for ecolabelling. Alternately, there could be LCA studies describing shrimp fishing techniques or fisheries management.

Once the controversy mapping is done, we will discuss what kind of practical applications are feasible. We hope to find ways in which the 'controversy mapping' method can inform the governance and management of product chains.

1.2. Theoretical background

Controversy Mapping is a tool developed to illustrate the concepts and ideas behind Actor-Network-Theory. This approach aims at providing insights on how to trace associations between both human and non-human actors (Latour 2005). The ANT approach is used when one wants to understand how these interact to produce a social result.

Mapping controversies provides a new perspective about the social—instead of looking into matters of fact, it focuses on *matters of concern* as key realms for social construction (Latour 2005, Venturini 2012). Matters of concern are unfinished issues under construction by many actors that interact through different devices. On the other hand, matters of fact are disputes that have been settled using scientific devices and that are no longer subject of questioning. Controversies reflect issues that are being discussed, that have not been settled yet because the different acting entities are still deciding where to go and who to mix with.

One of the key concepts used in Actor-Network-Theory is *translation*. According to Latour and Callon (1981), such a process comprises all the actions by which an entity they call actor gains the right to represent someone/something else; it is the process that turns the *I* into the *we*. Such actions include the most diverse mechanisms, ranging from violence to subtle acts of persuasion with science.

Translation can be described as a process with four stages (Callon 1984):

- **Problematization**: the main actor defines a problem and a network of other actors that are related to the scientific and technological challenge. S/he also establishes how these actors would be benefited by solving it, making it necessary for them to follow the scientists' advice or, more accurately, indicate what associations are needed to overcome the situation at hand.
- **Interessement**: this phase is defined as "[...] the group of actions by which an entity [...] attempts to impose and stabilize the identity of the other actors it defines through its problematization. Different devices are used to implement these actions." (p. 204).
- **Enrolment**: in this stage, the proving or discarding of the hypotheses the actors made about each other tests their interessement. The enrolment depends on many factors that need to be included in the negotiations for bringing the actors to become what they are supposed to be.
- **Mobilisation**: this step refers to how well the represented actors will follow what their 'representatives' have expressed. It also refers to the mechanisms by which the representatives are decided, elected or self-appointed, which affect how well the represented will follow. It depends on how well equivalences are established in order to successfully communicate the will of the represented to other actors.

As a result of the controversy, the different stages of translation are altered and a new translation is built. Once the process of translation is completed, it starts to be controverted, which according to Callon means that "the representativity of the spokesman is questioned, discussed, negotiated, rejected, etc." (p. 211). And so, it continues.

1.2. Controversy-related research in Industrial Ecology

Research seems to be limited, and in the few publications 'controvers*' is found, it appears as a general term, often for something the authors notes or speculates on in their studies. Only two publications can be said to explore a controversy in order to discuss methodologies in the Industrial Ecology field, more specifically in relation to life cycle assessment: the use of wastewater sludge on farmland (Bengtsson & Tillman 2004) and nanosilver (Boholm & Arvidsson 2013). In both studies, a limited controversy mapping is carried out, focusing on systematic analysis of viewpoints without going into constellations of actor-networks. It is concluded in both studies that the LCA methodology is insufficient and that there is a need to acknowledge value-laden issues in addition to facts (Bengtsson & Tillman 2004) and that its impact assessment methods cover many but not all matters of concern, e.g. public health and bacterial resistance in relation to nanosilver. Both studies can be said to be attempts at understanding the capacity of LCA methodology in a social controversy. Our intention here is different: how 'controversy mapping' as a methodology can inform the governance and management of product chains.

2. Methods – Controversy mapping and linking it to a product chain framework

We follow the approach to controversy mapping described by Venturini (2010) and Latour (2012). Some steps were added to allow for (1) the analysis of the presence of life cycle-related work in the controversy and (2) an analysis of the controversy from a product chain perspective.

2.1. Starting points

Controversy mapping is a tool developed to apply Actor-Network-Theory to socio-technical debates. Its objective is to facilitate observation and description of issues related to technology, science and politics in such a way that their complexity is not threatened by

pre-existing frameworks, perspectives or methods. For this, a set of principles for controversy cartography are stated (Venturini 2010):

> *"You shall not restrain your observation to any single theory or methodology; you shall observe from as many viewpoints as possible; [and] you shall listen to actors' voices more than to your own presumptions." (p. 260).*

Second-degree objectivity is a key concept. Instead of looking for agreements (matters of fact), second-degree objectivity looks for disagreements, or, in other words, for multiplicity of views about a specific object (matters of concern) (Venturini 2012). This allows an openness to a myriad of views, but it also requires the ability to give each view its 'proper' place on the map. This depends on three elements:

- **representativeness**: how many actors subscribe to a viewpoint,
- **influence**: position of the actors subscribing to the viewpoints or if they are 'obligatory passage points', and
- **interest**: diversity of actors and arguments related to the topic.

Controversy maps also need to exhibit *traceability* and *aggregability*. Traceability refers to the possibility to move backwards in the translation process in order to retrieve the complexity of the controversy and understand how the final representation conveys it. Aggregability aims at simplifying the amount of data gathered in such a way that it summarizes the complexity of the controversy. The abundance of digital tools and media today enables the building of maps that are traceable and aggregated from a wide range of sources: search engines to search the web; emails and other sources of data that are not findable through search engines (e.g. chats, teleconferences); offline digital files shared via offline devices. Although the digital world seems to be omnipresent, it is not. Great quantities of information are available in digital form, but large communities are not yet part of this sphere and still have key roles in controversies, which needs to be acknowledged by the researcher.

2.2. Procedure

Venturini (2010) and Latour (2012) provided guidelines for tracing controversies in the digital era through a series of steps:

1. **From statements to literature:** this translates into mapping the supporting references for controversial affirmations.
2. **From literature to actors:** these references come from different actors that are connected to other actors in intricate network(s).
3. **From actors to networks:** this refers to identifying the different relations that connect the actors observed in the controversy, how these connections appear and disappear.
4. **From networks to cosmos:** here the cartographer looks for the motivation behind the actors, the desire behind their behaviour, the meaning of their actions.
5. **From cosmos to cosmopolitics:** this step refers to the observation and description of how different meanings in the controversy prevail or fail.

We follow this approach to address the controversy at hand. However, some adjustments were made in order to accommodate to the information available and particular dynamics of this debate. To begin with, we added a preparatory stage, from media to statements, following a suggestion from Latour (2015). Then we stop the analysis at step 4 as it closes the descriptive part of the methodology. Instead, we added our own layer to the analysis, in order to evaluate how the controversy played out in the 'product chain' (see figure 2).

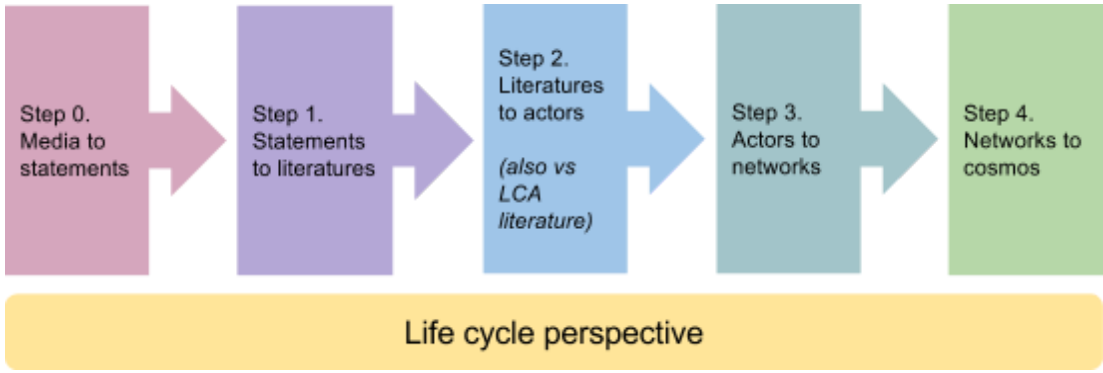

Figure 2. Procedure for the controversy mapping. Findings from the different steps are laid out along the product chain for the shrimp. Literatures referred to in the controversy (step 2) are related to LCA literature on shrimp fishing.

Once the empirical data was collected through the methods of controversy mapping, tools for analysis and visualization were used. We carried out social network analysis following the approach of Easley & Kleinberg (2010) and we used the Gephi software for visualizations. To analyse the relatedness of the controversy literatures and the LCA literatures on shrimp fishing, we used CitNetExplorer.

2.3. Data collection and coding

The first step to grasp a controversy is to carefully listen to *floating statements* and see who is involved in them and what are they based on. A natural place to start listening is the media, newspapers, radio, television and blogs. Our mapping started with identifying keywords, searching the internet and also setting alerts for news or blog posts in search engines. We selected the following:

Hållbart räkfiske (sustainable shrimp fishing)	Shrimp fishing sweden
Nordhavsräkan (Northsea prawn)	Sustainable fishing sweden
Räkfiske sverige (shrimp fishing Sweden)	Västkusträkan (West coast shrimp)

These alerts were set up from early October to early November in 2015.

Once the main sources of information were detected, the actors in each source were identified. It is important to point out that there were actors mentioned in the media without any statement specifically assigned to them while other actors explicitly stated their viewpoint. For the analysis, only the second group was considered.

Following this, their statements were documented in a database, coded and categorized, resulting in 13 categories.

After identification of viewpoints, the inquiry moved towards more 'solid' places. Such places are consist of the literature and references used by actors to support their perspectives. First, a list of the directly quoted documents was created. Then, each documents available was reviewed to identify further references. This collection, which we here call the controversy literatures, is what gets related to the LCA literature on crustacean fishing.

3. Results

3.1. From media to viewpoints - step 0

In total, 129 articles were identified in the web and screened for statements, resulting in 262 viewpoints being recorded in our database. In total, 169 actors were identified. 65 of these made a total of 80 explicit statements in media, thus became the main focus of the analysis. The remaining 104 were mentioned but with no statements attached to them. Since statements are the departing point for the mapping controversy tool, only the first group can be considered.

We used 12 field to describe each statement in our database (table 1). Each field characterises the collected statements in relation to the steps of the analytical procedure (figure 2), thereby enabling map-making throughout the procedure. All statements were also coded and categorized (table 2).

Table 1. Database fields used for recording and documenting viewpoints in the controversy. For each entry in the database, a maximum of 3 viewpoints were identified.

Field	**Definition**
Source	Link to the article
Media	Name of the outlet
Date	Date the article was first posted
Actor	Human or non-human
Type	Animal, artifact, individual, institution, organization, project, regulation or report
Influence	Defined as how big the audience an actor has: low, low-medium, medium-high, high.
Sector	Academia, fishermen, government, NGO, private
Statements	Explicit viewpoint assigned to each actor in the different sources they are mentioned.
Viewpoints 1/2/3	Coded positions (3 max.)
Literatures	References cited by the actors
Product chain position	Where is the actor located in the shrimp product chain: context, fishing, retail and use.
Link to the product chain organization	Whether the actor is directly or indirectly connected to the product chain organization

Table 2. Coding categories for the viewpoints.

Code	**Explanation**
ActionSustSHRMP	Action needed and taken to make shrimp fishing sustainable
ConcernBrandSHRMP	Concern about brand
ConcernOriginSHRMP	Concern about origin of the shrimp
ConcernPractSHRMP	Concern about the fishing practices
NOTConsumWWFOK	Consumer guide by WWF is NOT relevant
ConsumWWFOK	Consumer guide by WWF is relevant
EconomyoverEnvironment	Economy is more relevant than environment
LawICES	ICES is the ‘law’

RedlistSHRMP	Shrimp should be redlisted
NOTRedlistSHRMP	Shrimp should not be redlisted
StopSHRMP	Stop eating west coast shrimp
EnoughSHRMP	There is enough shrimp to fish
SustSHRMP	There is sustainable shrimp

The mapping starts with looking at the representativeness and influence for each viewpoint (figure 3). This done by relating each viewpoint to the number of actors behind it and to gauge the size of each actor's audience[1], respectively. The mapping of interest is done by looking at the diversity of actor types behind each statement (figure 4).

Figure 3 shows that some viewpoints have greater representation than others and that the dispute has opened the opportunity for actors to express opinions on many matters at hand. For example, here, there are two viewpoints with more actors behind them than others, one that the WWF consumer guide is relevant (ConsumWWFOK 45%) and the other the opposite, that it is not relevant (NOTConsumWWFOK 42%). This means that one position claims the WWF guide to be relevant for decision-making and should be taken seriously, while the other is that actors find it confusing and lacking a robust background, rendering it useless for purchasing decisions. Next comes the position expressing concern about the fishing practices for the West coast shrimp (ConcernPractSHRMP 34%), while its opposite viewpoint (SustSHRMP) only has 9% of the actors behind it.

Not all actors have the same power, and the viewpoints they support come across differently to their audiences (figure 3, right side). When looking at the viewpoints through the lens of actors influence, other viewpoints come to the fore as the most prominent ones. Viewpoints expressing concern about the origin of the consumed shrimp (ConcernOriginSHRMP) and the practices for fishing (ConcernPractSHRMP) come from more influential actors. Following these two is another set of opposing viewpoints, one that the Swedish shrimp should be redlisted (RedlistSHRMP) and the other that redlisting is too extreme an action (NOTRedlistSHRMP). With regard to the most represented viewpoints (left side figure 3), one can see that the view that the WWF consumer guide is relevant is supported by more influential actors than the opposite.

[1] Influence is measured here in terms of the size of the audience an actor can reach. Individuals with no institutional/organisational representation were ranked 1 since the size of their sphere of influence is modest; individuals associated with academia and private organisations were ranked 2; individuals from local government, companies and other organisations were ranked 3 and organisations and government officials from national/international level and public figures were ranked 4.
In order to calculate the level of influence for each viewpoint (VP), the number of times it (VPi) is mentioned by actor j is multiplied by the influence of the actor (IAj) and added. As a result each viewpoint obtained a score, allowing us to rank them.

Figure 3. Viewpoints according to representativeness (right) and influence (left). Size of circle is proportional to the numbers of actors behind a viewpoint (right) and the size of the audience for each viewpoint (left).

The reason for looking at diversity behind viewpoints is to identify which views are more mainstream and which are the more lonely voices that tend to disagree with the majority (Venturini 2012). Figure 4 shows that there is only one viewpoints is represented by all types of actors and in all sectors—it is the viewpoint that highlights the relevance of WWF's consumer guide (ConsumerWWFOK). Another two viewpoints also have a broad base: concerns about the practices around shrimp fishing (ConcernPracticesSHRMP) are raised by all types of actors (figure 4 left side) and the opinion about red listing of the shrimp is raised in all sectors of society (figure 4 right side). Other perspectives with narrower representation not to be forgotten are ‘economic aspects are more important than environmental, ‘concern about the origin of shrimp’, ‘the need for actions towards sustainable fishing’, ‘concern about the impact on Gothenburg's brand’, ‘the preeminence of law over consumer guides due to the scientific basis’ and ‘the call for stopping shrimp consumption’.

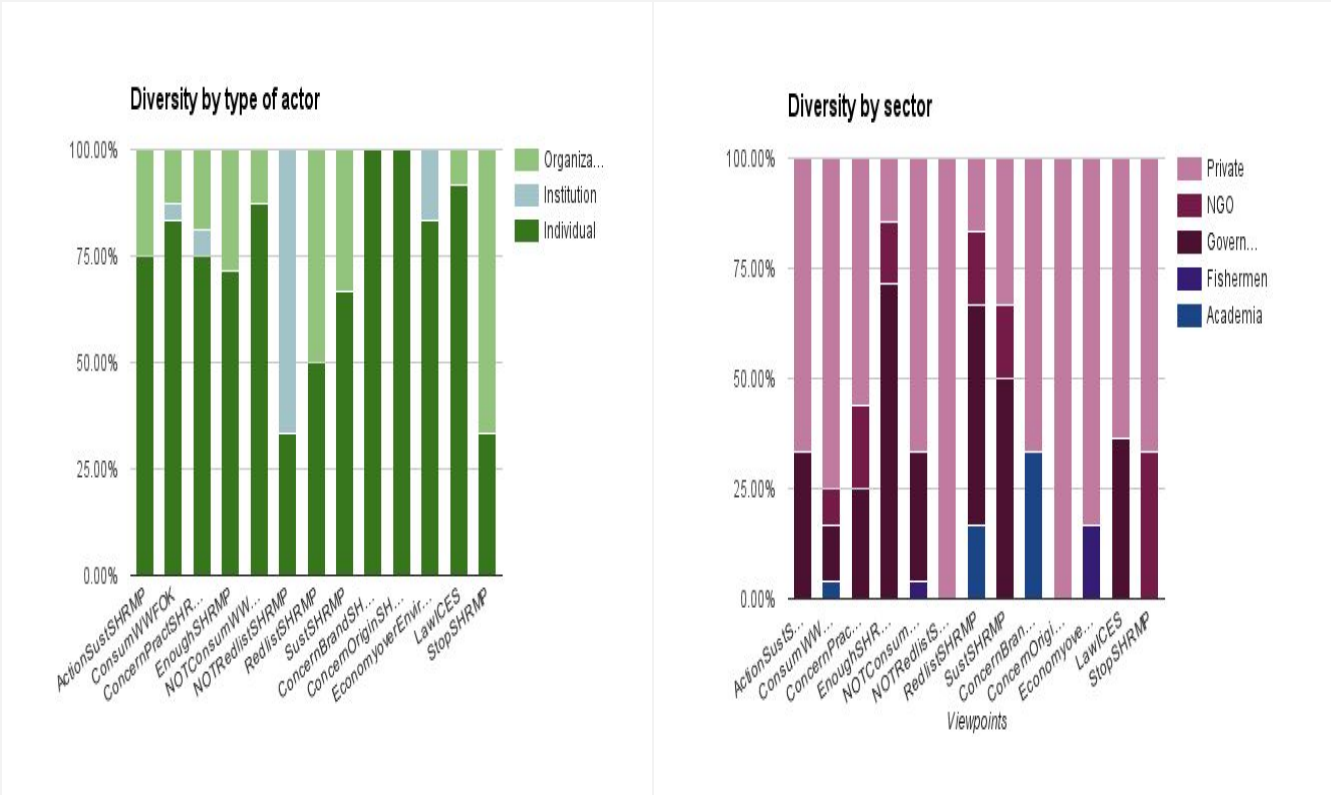

Figure 4. Diversity of interests behind each viewpoint.

3.2. From statements to literatures - step 1

The literatures that are called upon by the actors to support their views are identified. In turn, this will lead to the identification of other networks invoked via the literatures.

A core group of references were identified (table 3). These include voluntary standards for fishing, regulation at national and international level, scientific reports on the state of marine resources and projects to improve fishing practices.

Table 3. *Core literatures in the controversy, used by actors to support their views.*

HaVs control strategy	ICES report 2013
KRAV procedures	Motivation for trawling ban in Kosterhavet
Quota regulation	WWF fiskguiden
Red list Artdatabanken	Fishermen's Union's assessment (Not available)
Nordic Choice Hotels guide (Not available)	WWF-FRV project on selective gear (Not available)
MSC certification for Sweden Skagerrak, Kattegat and Norwegian Deep-cold water prawn	

In figure 5, we map the literature against the viewpoints (figure 5). It points out two documents as the main protagonists. These documents are the ICES report 2013 (Ulmestrand et al 2013) and the WWF consumer guide on fish (WWF 2015).

After these two, the Nordic Choice Hotels purchasing guide and the WWF-FRV project report on selective gear for shrimp fishing are the next prominent reports. Less cited sources are the assessment conducted by the fishermen's union, mentioned by one of its members, and the quota regulation established by the European Union, enforced by Havs- och vattenmyndigheten in Sweden. Also in this third group is the certification documents

developed by DNV to support the MSC-labelling process started by the Gothenburg's Fish Auction.

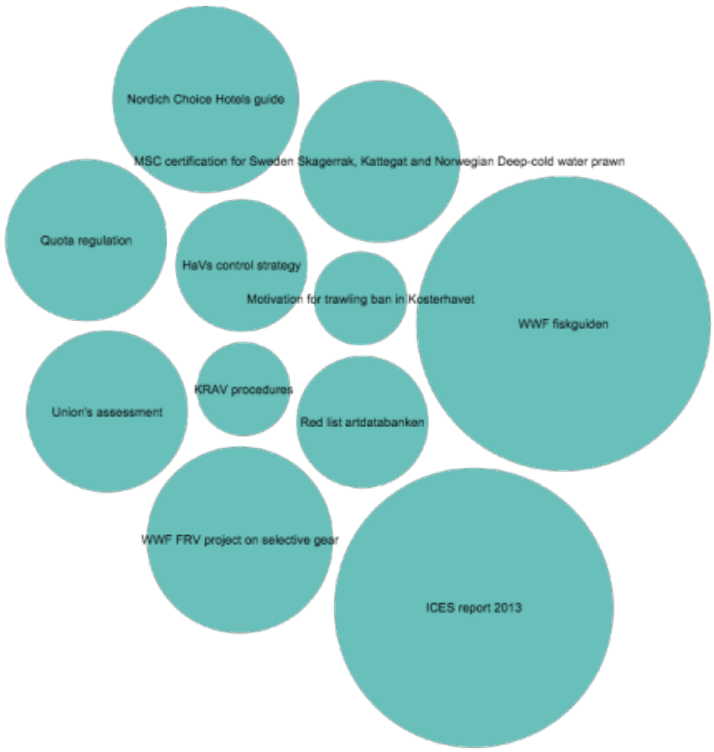

Figure 5. Literatures by the number of viewpoints referencing them.

Most of the arguments and viewpoints presented in the controversy are supported by technical reports that are mainly based on secondary information that has gone through different interpretation processes by the actors producing them and the actors quoting them. This leads to a transformation of the intended message by the original authors. How the information plays out in the discussion depends on who the actors are, their interests and the role they play in the debate. This becomes evident with the manner the ICES report 2013 is quoted by both sides in the controversy regarding the relevance of WWF's warning.

As suggested by Venturini (2010) and Latour (2012), we also traced the second-order literatures to obtain a wider picture of the network of supporters to the viewpoints. The identification of second-order literatures allowed us to make several observations. First, there are different levels of support in terms of number of reference for this group. Documents such as the ICES report from 2013 and the MSC certificate for the Swedish Pandalus borealis fishery make use of a great number of references. In contrast, literatures such as the WWF consumer guide, the quota regulation document from the Havs- och Vattenmyndigheten and the KRAV standards do not reference any documents. Artdatabanken's 2015 Redlist includes a small list of references. If this information is analysed from the perspective of viewpoints, figure 6 is obtained.

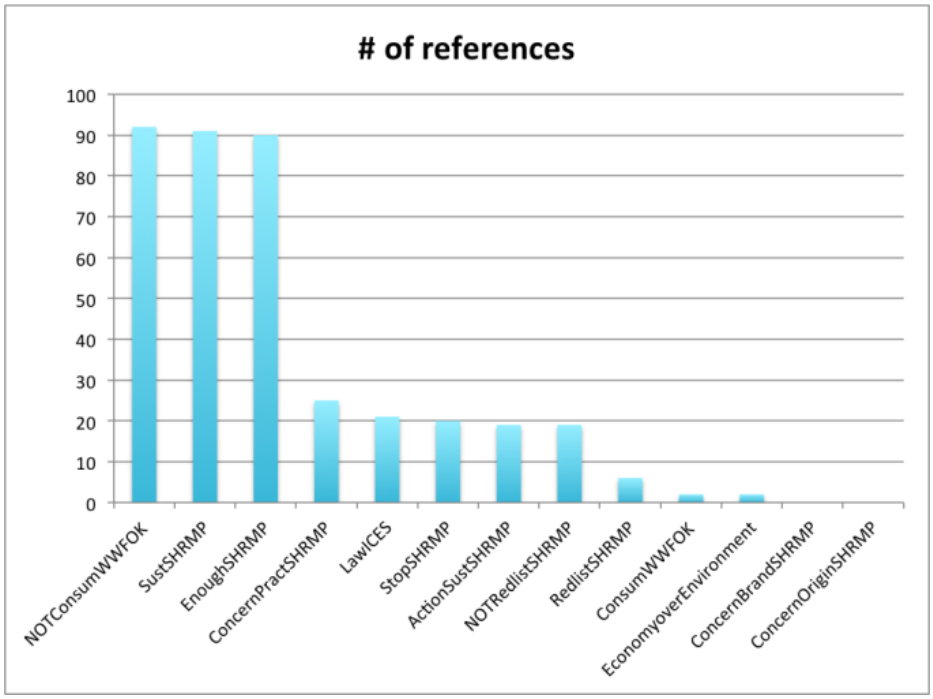

Figure 6. Number of references behind each viewpoint

Figure 6 shows that views stating that there is no problem with the Pandalus borealis have the greatest support in terms of number of invoked references, whereas support to the WWF consumer guide warnings is considerably smaller, with few references behind it. Other viewpoints, such as those expressing concern over the origin of the shrimp, the role of the shrimp as a brand for Gothenburg or the relevance of economics over environmental concerns are in the same situation.

Another dimension of the analysis of these literatures refers to what kind of support they provide to the different viewpoints. The ICES 2013 report is based on technical reports created by its working groups on different topics (19). The MSC certificate is supported by a large number (71) of references that include technical reports by ICES and other scientific bodies, peer-reviewed articles and regulatory documents. Artdatabanken's 2015 Redlist is also based in similar documents, and also includes the ICES reports in its reference list.

It becomes clear that the viewpoints claiming that the alarm raised by WWF is inaccurate have the most references supporting them. The supporting literature consists of technical reports, regulatory documents, and peer-reviewed publications.

There seems to be no apparent correlation between robustness of the sources and invocation by actors. A well-supported literature such as the ICES report 2013 and a weakly supported report such as the WWF fish guide are equally used by the different actors.

Another conclusion is that the traceability of sources is not evenly distributed among literatures and this seems not to affect the trust by the audiences. What was found in the case of WWF fish guide was that we were not able to access the sources for the guide, not even when asking directly. In contrast, all the documents behind literature for the ICES report 2013, the MSC certification and the Red List are openly listed. The unavailability to references raises questions about accountability and transparency of instruments such as WWF's fish guide.

3.3. From literatures to actors - step 2

The identification of actors involved in the controversy is based on an analysis of both the statements and the literatures behind the statements.

If the analysis were restricted to only actors making explicit statements in the media, several types of actors would disappear, and only individuals, institutions, organizations and reports would remain. We identified ten types of actors.

1. Animal. Here, the North Sea prawn, with its particular (biologic) life cycle.
2. Artifacts. Here, mainly trawling technology. In Skagerrak, demersal trawling (trawling close to the seafloor) is used with nets that can discriminate shrimp by size.
3. Individuals. Many individuals are often representatives of macro-actors and play a role in translation. We identified 75 individuals from different sectors, with different levels of influence, and therefore with different roles in the controversy.
4. Institutions. Here, informal yet established social arrangements, such as the 'market', 'demand' or 'consumers'. In media, around 10 such institutions were mentioned. Although they were assigned a viewpoint by the media, it is very difficult to assess what these institutions stand for.
5. Organizations. Formally established organizations, e.g. WWF, ICES, Havs- och Vattenmyndigheten, etc. These are considered to have agency on their own. Organizations have individuals that speak on their behalf. When such people speak as representatives, their voices are heard by a larger audience than the one directly addressed.
6. Place. Controversies often have a geographic dimension. Here, it takes place on the Swedish West coast, more specifically in the ports where shrimp is landed and the marine areas where fishing is controlled. Places explicit in the media were Kosterhavets National Park and small harbors on the coast.
7. Projects. Only one project was mentioned in the media as part of the controversy. It is considered a type of actor since it is a collection of ideas, individuals, organizations and resources of its own. It is not uncommon to hear individuals present themselves as belonging to a project instead of an organization.
8. Region. Also regions are considered as actors since they are summoned by spokespeople when stating a viewpoint. Here, at least three countries are involved, and several municipalities and cities.
9. Regulation. Laws, regulations or rules are also considered as actors since they influence the behavior of other actors and are, in turn, affected by the decisions of other actors. They are protagonists in this controversy since they affect the sustainability of fishing activities. Identified regulations include the quota system for fishing defined by the EU, rules on landing and certification rules.
10. Reports. Key devices to 'translate' information, knowledge to different audiences. Prominent protagonist reports here are the annual WWF consumer guide to sustainable fishing and the annual ICES report on shrimp.

A simple analysis (figure 7) of the actors present in the controversy shows that:

- Individuals (39%) were the main protagonist of the different media pieces on the controversy followed by organizations (23%) and animals (10%). Other elements like technology, regulations and report were also present but not mentioned as frequently as the others.
- Private actors were most present (57%) in the media, followed by government (27%) and non-governmental organizations (17%). Academia was quoted only in very few places (5%).

- Of all the actors in the media, 35% were classified as having medium-high influence and 14% as having high influence. Common actors with low to medium influence represented only 33% of the mentions in media.

Based on this, we remark that influential individuals from private sector shaped the public debate by being consulted by media outlets, while less influential actors had less space in these outlets to express their viewpoints. And, although academia is key in a science-related controversy, it was poorly represented in published media.

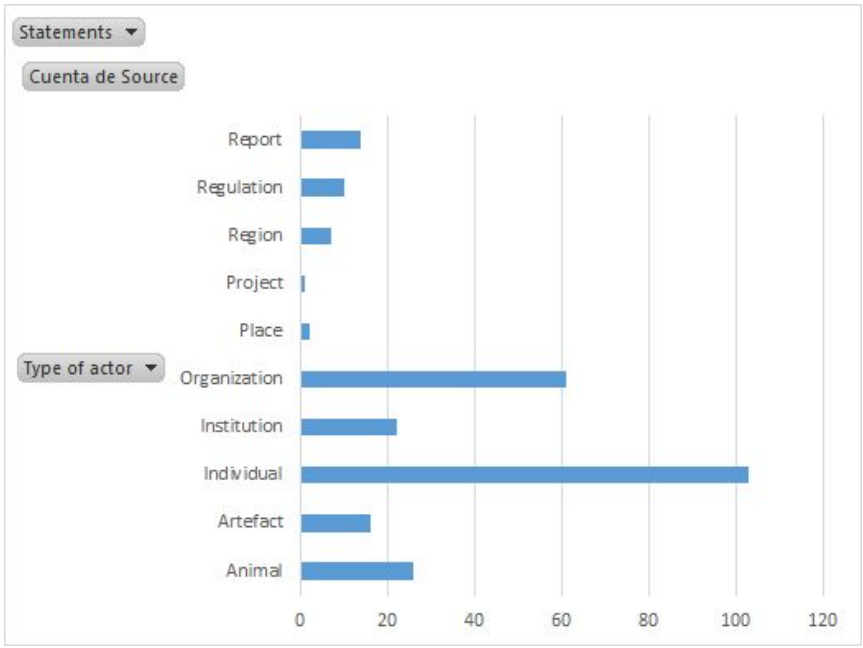

Figure 7. Number of mentions of different types of actor in the media.

3.4. From actors to networks - step 3

Connections between actors need to be identified. Actors can be connected to other actors via shared viewpoints and literatures. We looked at the actor-networks emerging through shared viewpoints (figure 8) and through the literatures (figure 9).

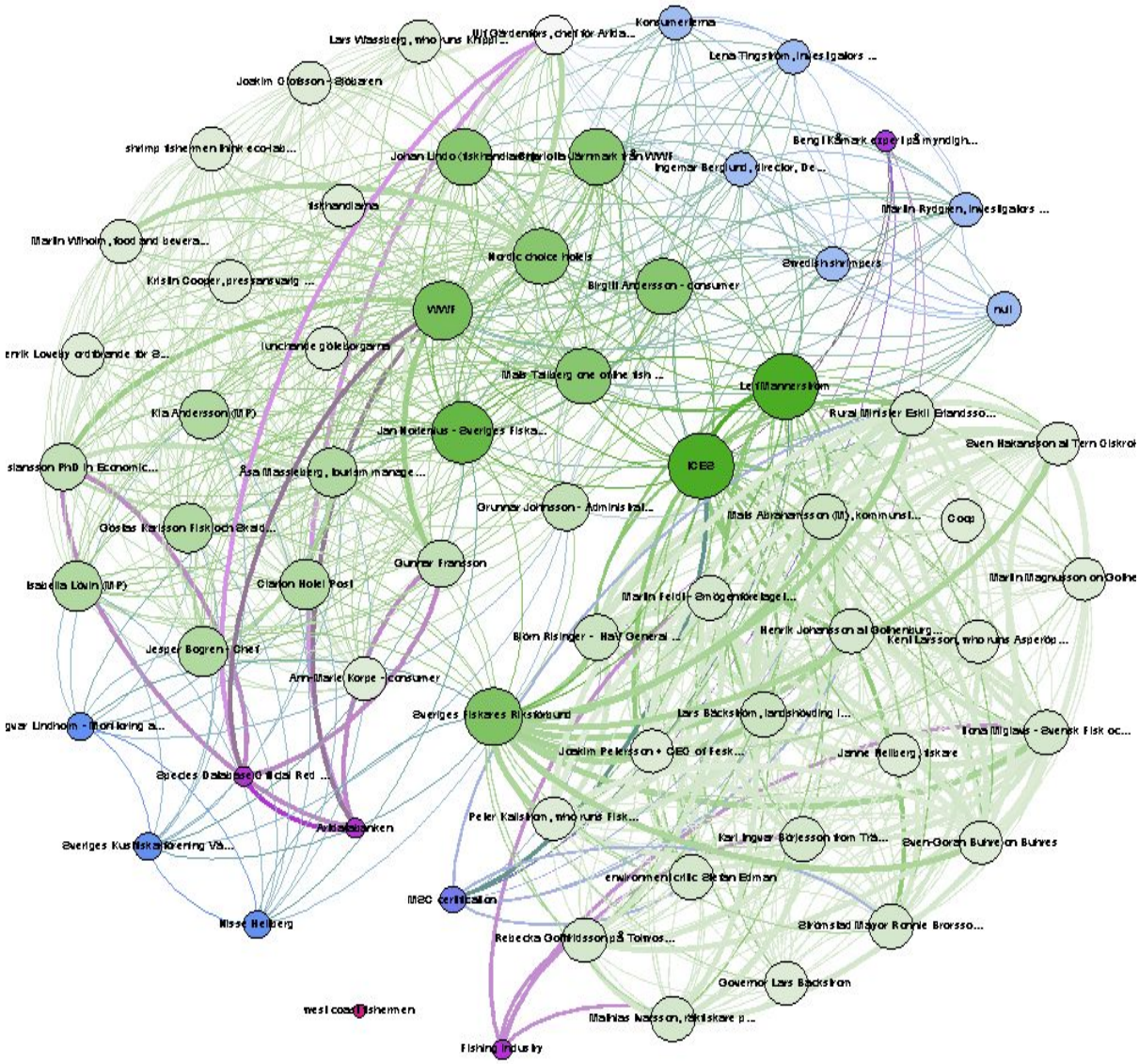

Figure 9. Visualization of actors connected through viewpoints.The actors (nodes) share between 0 and 40 connections, i.e. an actor do not share any viewpoint with any other actor or up to 40 different actors. Colours and circle size to accentuate the connectedness of actors, where deep green show the most connected actors and purple the 'lonelier voices'. The spatialization algorithms were Fruchterman Reingold (25.000, 10, 10) for untangling the random initial layout. (Better resolution graphs are available in our blog about the controversy at https://unravellingthenet.wordpress.com).

Two clusters appear from the network analysis in figure 9. One centers around WWF's perspective on shrimp fishing on the Swedish West Coast (left). It includes mainly private individuals and organizations. The other (right) revolves around ICES, the fishermen's organization and the public figure Leif Mannerström (a celebrity chef). There, one also finds the government, public figures and fishermen actors.

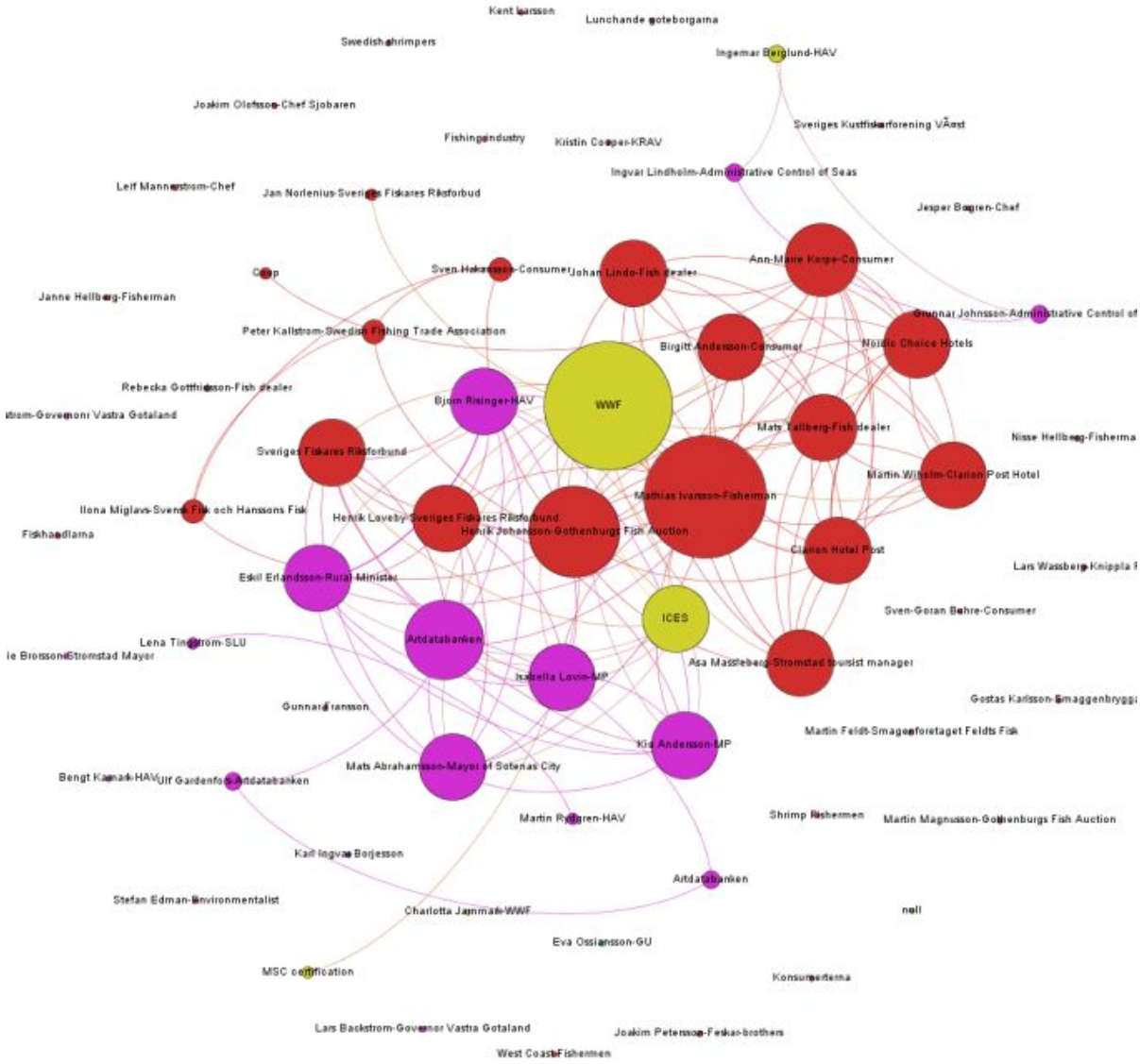

Figure 10. Map of actors connected through literatures. At most, two actors share 20 references, while some do not share any. The colours represent the sector each actor comes from: private (red), governmental (pink), NGO (yellow). The larger the circle, the greater the number shared literature references. (Better resolution graphs are available in our blog about the controversy at https://unravellingthenet.wordpress.com).

Two groups appear in figure 10, one with a tight network of links and another one floating around without connections. In the first group, two actors show the highest level of degree centrality: WWF and fisherman Matthias Ivarsson. In the second group are the actors whose statements and literatures are not used by any other actor.

Based on the network analyses we could identify two opposing sides in the controversy. The actor-networks on each side called upon a supporting actor-network through the literatures. This results in that people in science and knowledge networks, with their institutions and resources were called upon in a specific issue they were not aware of. Moreover, we see that

the opposing 'camps' use the same sources—this suggests to us different interpretation of those sources.

3.5. From networks to cosmos - step 4

The last step in controversy mapping is to understand the ideologies behind the statements, arguments and connections. Ideologies are expressed through the meaning actors attach to these elements (Venturini 2010). Such meaning can only be suggested as it is not explicitly revealed in the literature or through the interviews.

In this controversy, two pairs of opposing viewpoints came to the fore: the reliability (or not) of WWF's warning and the sustainability (or not) of shrimp fishing on Sweden's West coast.

The first dispute touches upon different elements, for example, how much legitimacy could a non-governmental organization have to provide consumers advice on what to buy or not. Put differently, how robust are the conclusions of WWF's report compared to sources used by the government. On another level, this dispute addresses the role of authority based on scientific facts in society.

Another dispute, the controversy about the actual sustainability of shrimp fishing in the west coast of Sweden gets connected to topics of culture, livelihoods and the traceability of products. Some actors express the importance of knowing where such a relevant product comes from; others assume that the system works and shrimp is thus fished sustainably. The meaning of their statements and their associations could be attached to their trust in different institutions or not. Their cosmos is that we as consumers, on the one hand, have a responsibility to make informed choices to guarantee the sustainability of much appreciated products and on the other, are the ones that transfer that responsibility to the institutions build by society.

In sum, several 'cosmos' can be suggested in this particular controversy:

- 'Authority to affect consumers decision can only come from governmental institutions' vs. 'civil society organizations and non-governmental organizations play a key role in decision making at the societal level'.
- Scientific knowledge is the legitimate source of knowledge and advice.
- 'Stewardship of natural resources is a responsibility of citizens' vs. 'stewardship is a responsibility of institutions'.

3.6. Presence of life cycle thinking in the controversy

Research publications on shrimp, life cycle assessment and Kattegat/Skagerrak were identified through searching Web of Science, Scopus and Google Scholar. The search results were filtered by looking for articles addressing only wild catch of shrimp or prawns from a life cycle perspective. Asian studies were excluded since they are not geographically relevant here. Finally, in order to be able to use the bibliometrics software CitNetExplorer, only records available in Web of Science were used. This rendered around 20 articles on crustacean LCA.

Correspondingly, the controversy literatures were also searched in Web of Science. This showed that only around 25 publications (out of 100) could be found since many of the controversy texts were technical reports and regulatory documents. We reviewed the technical reports for references but these were again other technical reports not in Web of Science.

To establish the links between controversy text and LCA texts, CitNetExplorer software visualizes connections as citation networks over time (figure 11).

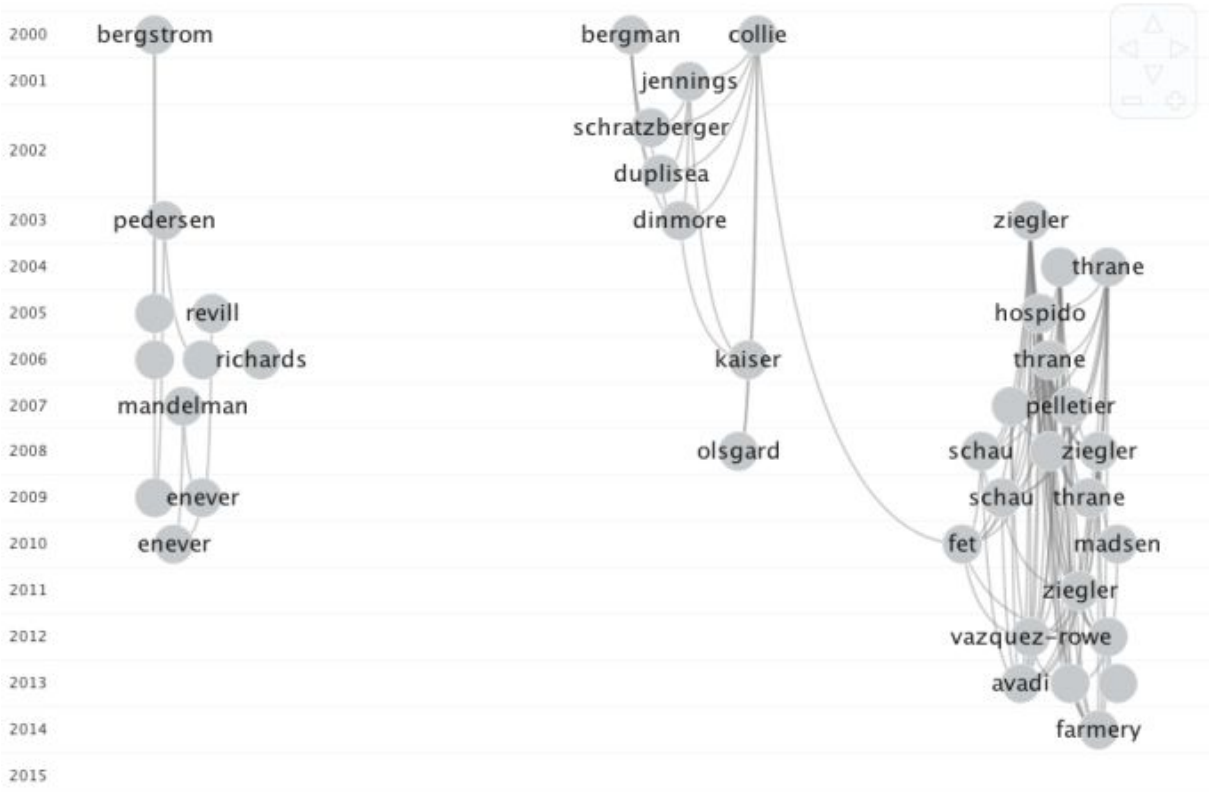

Figure 11. Citation networks. At the top are the oldest publications or cited documents, the lines represent citations and at the bottom are the citing articles. Three groups are identified. The two on the left are publications related the controversy's viewpoints. On the far right is the group of publications with an LCA approach. Between groups 1 and 2 are no connections but between group 2 and 3 appears a first connection at this scale between Collie et al (2000) and Fet et al (2010).

Analysing the graphics in figure 11 in greater detail, more connections between group 2 and 3 appear. We find three connection, between Collie et al (2000) and Fet et al (2010), Collie et al (2000) and Langlois et al (2011), and between Collie et al (2000), Kaiser et al (2012) and Farmery et al (2015).

We can see that the LCA literature has benefited from the literature used to support the viewpoints in the controversy, not the other way around. This is noteworthy since a large number of LCA publications are contemporary or even preceded some of the articles used in the controversy.

With regard to the controversy, the LCA-related literatures have not been considered in the publications used to support the different viewpoints. Instead, the peer-reviewed publications used in the controversy were later used in LCA publications on shrimp and wild-caught seafood. In sum, the LCA research is not involved in the controversy.

3.7. The controversy over the shrimp product chain

Viewpoints and their actor-networks were placed within the framework of the shrimp product chain, a simple model of the production and consumption system for the West coast shrimp. We divided the immediate product chain into fishing, retail and use, and included also surrounding actors (government, NGO, etc).

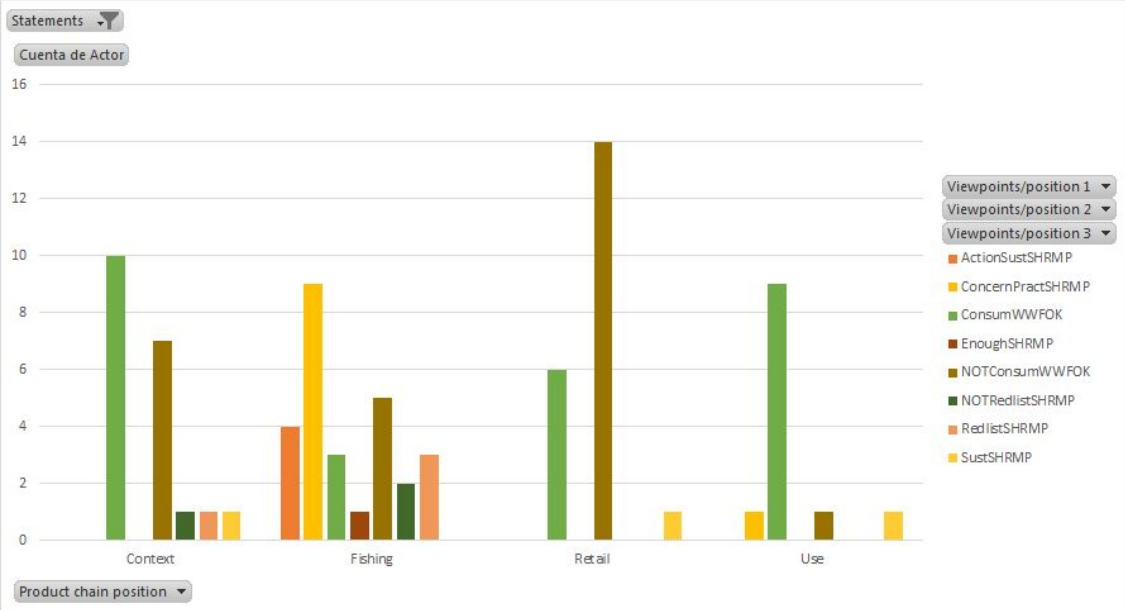

Figure 12. Viewpoints per stage of the shrimp product chain.

Figure 12 shows that actors in the retail step are the most skeptical about WWF's warning, whereas the users are more supportive of the warning. The fishing stage exhibits the most diverse viewpoints. Among surrounding actors, opposing viewpoints are found on the reliability of WWF's warning.

The notion of a simple product chain perspective is present in the public debate since actors from the different stages are present. However, when looking at the distribution of the different actors, we found that the best represented stage of the product chain was 'fishing' (57% of the actors). Given the fact that the controversy revolved around the practices in this step, it could be expected to be well represented in the media. Retail and users were represented on equal levels, but surrounding actors were present to a greater extent and had more chances to express their views than the former two. In terms of a production and consumption system, the controversy is played out as a debate engaging mainly the production system, not the consumption system.

4. Analysis and discussion

Following the Controversy Mapping method, we have attempted presenting as much information as possible in a way that tries to minimise our room for interpretation. Using all the maps and graphs presented, we move forward to analyse how different aspects of the controversy affect the environmental sustainability of our main protagonist, the Swedish West Coast shrimp.

4.1. Attempting to understand the controversy

What started out as an apparent controversy around the sustainability of shrimp fishing turned out to be a controversy centering on the legitimacy of one actor's call to stop consumption of shrimp from a particular stock. Nested within this dispute is a smaller controversy, one on whether or not there are enough shrimp in the sea. Going back to Callon (1984), we see that the matters of concern in this controversy are more about the legitimacy

of advice given by an actor or the "scientific knowledge" behind it, and less about the sustainability of shrimp fishing practices.

If the main dispute revolved around WWF's legitimacy for red-lighting the Swedish West coast shrimp, even louder voices from the government and industry (e.g. Agricultural Minister Eskil Erlandsson or celebrity chef Leif Mannerström) argued about the accuracy of redlisting the shrimp by actors such as Artdatabanken, affiliated with IUCN. Views related to red-lighting/redlisting support or doubt if shrimp is in danger, and refer to evidence or lack thereof concerning the state of the stock. It seems thus that organizations and public figures are more concerned about science and evidence-based viewpoints than regular individuals.

Another finding is that the sustainability discussion focused on one stage of the product chain, fishing. Both WWF's warning and Artdatabanken questioning pointed to problems during the fishing phase of the product chain. The situation of the stock, the lack of control and the poor management practices all happen in that stage. However, some interviewed actors also pointed out other problems in the product chain, such as the peeling process that might not follow sustainability principles as the ones required for the fishing stage. This results in a bounded understanding of the sustainability of the shrimp. Although the aim of actions such as the red-lighting from WWF aims at affecting practices in one stage of the chain by influencing other part, it misses the opportunity to achieve a life cycle perspective.

Nonetheless, the product chain perspective is visible in the controversy since some of the downstream participants, actors such as retailers and consumers, intervene in the discussion even though they seem disconnected from the fishing phase. By entering the controversy, they provide perspectives that otherwise might not have been consulted for the sustainability of the Swedish west coast shrimp.

Mapping the controversy over the product chain provided an understanding relating to the identification of surrounding actors indirectly affect the functioning of the product chain. Such actors include media, governmental and non-governmental organizations, and also influential individuals. These actors exert their influence on consumers, producers and distributors, through different devices. Media which includes traditional outlets such as newspapers, radio and television provide a platform for proponents of different viewpoints but media can also manipulate the amount of exposure a particular perspective gets which in turn affects perception of audiences. Governments intervene the product chain through regulation and enforcement strategies as ways to force a specific outcome onto the different stages in the chain. They also define the price indirectly through the quota regulation, the permits for vessels, etc. Finally non-governmental organizations are also part of the context of the product chain by playing different roles, including fiscalization.

However, during data collection, some interviewees pointed to that relevant actors were absent in the media, e.g shrimp peeling companies or distributors different from Gothenburg Fish Auction. Media itself then must be viewed as an actor in the controversy since it decides who has a worthy perspective and who doesn't.

The translation process going on in this controversy revolves around the sustainability of Pandalus borealis fishing in Swedish waters. It started with the warning from WWF, asking if shrimp fishing was sustainable in this particular area in 2013. As mentioned, this is the first step in a translation process (Callon 1984). The question had been asked continuously since 2000 by WWF, and in order to obtain an answer, they designed a methodology based on particular approaches, presented as their consumer guide. In this way, WWF set the problem and fulfilled the stage of problematization.

The second stage, interessement, is about making other actors interested in their project. WWF's approach aims at engaging consumers and retailers to stop buying species under red light classification. They also need to engage scientists to provide the scientific basis for their guide. Media is also relevant for reaching out to target audiences.

Alas, the WWF guide for 2016 was not published in February as usual so we don't know the verdict for the shrimp. Currently, the shrimp is both red-lighted, redlisted yet sold with a Marine Stewardship Council ecolabel. This is still a very open controversy.

4.2. Our experiences with the Controversy Mapping method

Working with controversy mapping has been very interesting — it defied our simplified notions about the controversy through the maps that captured all statements and actors and their relative position. The method itself is both time-consuming and efficient at the same time: the tagging and coding of the material takes time, but with a database in place, analytical graphs could be put together with relative ease. Interpretation of the multi-faceted graphs can be challenging, yet inspiring and exciting as they helped us see actors related to each other in novel ways, for example, related through shared literatures. With more experience, we could have had more fields in our database enabling further analysis (e.g. development of controversy of time) and more developed visualizations. Here, we settled for Gephi, but on the 'Controversy mapping' resource page at Science Po, 13 more tools are suggested.

A *public* controversy is necessary for access to statements. However, the controversy itself may also lead to cautious actors. Some interviewees preferred not talking about past and contested events. Moreover, not all environmental issues turn into controversies. The shrimp debate was less heated in Norway and Denmark than in Sweden, in particular in and around Göteborg — the humble shrimp is certainly a matter of great concern in 'city of the shrimp' thereby announcing a *cultural* dimension to the controversy. The Norwegian press referred to the 'acute situation' in Sweden, where prices sank with 50% and demand plummeted, while prices only sank with 10% in Norway during the same period. Actors in the Norwegian industry and authorities were also reported to respond quickly, seeking solutions as to avoid the Swedish situation (Stavanger Aftenblad 2014).

5. Conclusions

Controversy mapping helped isolating the issue(s) at heart of the controversy. A quick look to the media indicated the discussion to be about the sustainability of shrimp fishing on the Sweden's west coast, however that was not the issue. Using the mapping methodologies, we found the real matter of concern being the legitimacy of certain actors' strategies for improving sustainability. The method also allowed us to evaluate the significance of 'scientific knowledge' in shaping opinions. What we discovered is that people rarely look for it to back their opinions. Instead, many turned to reputation and 'good-will' for reference.

In this controversy, we noted that the opposing 'camps' used the same information but in different, suggestion different interpretation of it. This could in itself warrant further research on this controversy, but we identify some dimensions where alternative interpretation are possible: 1/ different timeframes when analysing shrimp statistics, 2/ stock & reproduction dynamics incl. recruitment, 3/ things that affect reproduction dynamics, such as illegal practices, 4/ stock vs population.

Mapping this controversy over the shrimp product chain enabled understanding of how different how different parts of the chain interact. What started with the publication of a

consumer guide turned into a controversy in which production actors and actors surrounding the product chain were the most engaged.

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