Swedish Institute for the Marine Environment

SOCIETAL DRIVERS BEHIND PRESSURES ON THE MARINE ENVIRONMENT

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Within the Swedish Institute for the Marine Environment, the University of Gothenburg, Stockholm University, Umeå University, Linnaeus University and the Swedish University of Agricultural Sciences work together to support authorities and other marine actors with scientific expertise.

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FOREWORD

In this report, the Swedish Institute for the Marine Environment reviews the concept of driving forces and how such forces can be considered within marine management work to develop measures and policy instruments for a better marine environment. This report has been prepared on behalf of the Swedish Agency for Marine and Water Management and is an adapted version of a Swedish-language report, 'Drivkrafter i samhället bakom belastning på havsmiljön' (Swedish Institute for the Marine Environment report no. 2020:8). Although many of the presented examples relate to Swedish challenges and conditions, it is hoped that they can also inspire continued broader work since the highlighted scientific methods are based on an international scientific foundation.

Assessments carried out to date on pressures on the sea and the environmental status of Baltic and North Sea coastal and offshore waters indicate that more and new measures are required to achieve a better marine environment. This in turn means that methods and data for drawing up such measures need further development.

One area that would benefit from further understanding is the diversity of actors within society who contribute to pressures on the sea, and the drivers behind different actions or behaviours of actors. This report aims to show what drivers are at societal, organisational and individual levels. It also aims to provide an overview of how the concept of drivers has been used to date within marine environment-related research and management, and how the actions of actors are linked to drivers. Greater awareness of behaviours of actors, and their drivers and barriers could contribute to marine environment management receiving better support for identifying and devising more effective measures.

The report was written by Eva-Lotta Sundblad, Anders Grimvall and Ulla Li Zweifel. The authors are responsible for the report's contents and conclusions. The report is aimed primarily at those working within marine management. It is hoped that it can also inspire researchers and research funders with responsibility for interdisciplinary knowledge that encompasses multiple sectors.

The authors would like to thank Marmar Nekoro (Swedish Medical Products Agency), Stina Olofsson (Focus on Nutrients), Ola Svahn (Kristianstad University) and Anna Ek (Swedish Agency for Marine and Water Management) for sharing their suggestions for documentation, information and knowledge. Thanks also to three anonymous reviewers who helped to improve the report with their critical and constructive comments, and to our colleagues who have provided support in various ways.

Eva-Lotta Sundblad, Anders Grimvall, Ulla Li Zweifel, 17 August 2021

ABBREVIATIONS

DPSIR	Driver–Pressure–State–Impact–Response, a framework describing the relationship between society and the environment
EC	European Commission
EEA	European Environment Agency
Eionet	European Environment Information and Observation Network
EU	European Union
FASS	Farmaceutiska Specialiteter i Sverige, a summary of pharmaceutical facts from the pharmaceutical industry
UN	United Nations
HELCOM	Baltic Marine Environment Protection Commission, also the Helsinki Commission
ICES	International Council for the Exploration of the Sea
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IMO	International Maritime Organization (a UN organisation)
IVL	Swedish Environmental Research Institute
LRF	Federation of Swedish Farmers
MSC	The Marine Stewardship Council, which certifies sustainable professional fishing and issues an ecolabel for products
MSFD	Marine Strategy Framework Directive
OECD	Organisation for Economic Co-operation and Development
OSPAR	The OSPAR Convention for the Protection of the marine Environment of the North-East Atlantic, managed by the OSPAR Commission
PFAS	Per- and polyfluoroalkyl substances, a collective term for a large group of organic substances with an alkyl chain in which some hydrogen atoms have been replaced with fluorine atoms
STECF	Scientific, Technical and Economic Committee for Fisheries, an advisory committee appointed by the European Commission
UNESCO	United Nations Educational, Scientific and Cultural Organization

CONTENTS

SUMMARY

In this report, we have reviewed the concept of societal driving forces and their impact on the pressure on the marine environment. In order to support marine management, the report discusses how drivers and barriers affect behaviours of actors and how such phenomena can be analysed methodically. The report also highlights the role that drivers in the form of large-scale societal phenomena can play in the development of environmental impact at global, regional, national or other large scale. In addition, it illustrates how the two driver perspectives (drivers for behaviour of actors and large-scale societal phenomena) can be used in marine environment management and the work to implement the EU's Marine Strategy Framework Directive.

A literature survey showed that there are relatively few scientific articles about drivers affecting the marine environment, and only a small number of these deal with the seas around Sweden. However, more studies and work are published in grey literature. Selected examples are presented in detail to illustrate concepts and outcomes.

This report also addresses studies that highlight methods for analysing drivers and barriers for environmentally friendly behaviour as a basis for developing policy instruments. One conclusion is that the marine environment can be affected by drivers at global, regional, national and local levels. The report also points out that the documentation for developing measures at national and regional levels needs to be extended and made more specific so that it highlights actors and their drivers and behaviours at several different levels within society.

In comparison to the term *activity*, which is used in the implementation of the Marine Strategy Framework Directive to describe areas or sectors in the society, the term *actor* is more specific since an individual activity can be linked to many different actors. Actor analyses can also identify additional individuals and organisations that affect pressures on the marine environment in various ways. Such analyses can thus strengthen the work involved in meeting the Directive's requirements for developing measures to deal with significant pressures. The report shows that there are additional actors other than the ones normally highlighted in the currently used methods to reduce pressures on the marine environment.

The review of scientific articles and reports showed that there are methods for carrying out all the stages included in a combined analysis of drivers, actors and behaviours. However, there is a lack of in-depth analyses that cover the full spectrum from drivers and actors to developing measures and policy instruments. This may be because an analysis which is intended to provide support for development of measures and policy instruments need to focus on a relatively specific environmental issue, since behaviours of actors are context dependent. Since large sections of society carry out activities that have an impact on the marine environment, the policy instruments and measures need to cover multiple sectors and sector authorities. Analyses of drivers and actors within society support a sector-wide perspective by naturally including actors in several respects. Such analyses could thus support developing measures for a better marine environment.

1 INTRODUCTION

In many countries, there is a widespread tradition within marine environment management of measuring or estimating pressures on the marine environment from sources on land and at sea. However, there is no corresponding tradition and knowledge within marine environment management of analysing what drives organisations and individuals within society to take actions that increase or reduce pressures on the sea. This limits the opportunities for identifying effective measures for a healthier marine environment.

Measures to reduce the food sector's impact on the marine environment have long focused on how food is produced, but less attention has been paid to the questions of what drives demand and what is produced. Tourism, marine debris and pharmaceutical use are examples of areas that represent growing threats to the marine environment where many actors are involved. These and other examples strongly suggest that the work involved in developing and implementing measures for a better marine environment need to be based on broader data including also actors and societal drivers. In particular, there is a need for more in-depth knowledge and greater awareness about the behaviours and underlying drivers that may persuade various actors within society to act in a way that reduces the impact on the marine environment.

Figure 1. The pressure on the marine environment can be seen as a combined effect of behaviours and underlying drivers among all actors.

In order to describe the content of this report, a few key terms need to be defined. In this report, the term *pressure* refers to biological, chemical or physical pressures as defined in the EU's Marine Strategy Framework Directive (2008/56/EC, Annex III, Table 2a).

The term *actor* represents individuals, businesses, agencies, politicians, organisations and

other parties who directly or indirectly influence pressures on the marine environment.[1]

The term *behaviour* refers to actors' actions, such as producing pharmaceuticals, driving cars, sorting waste or not complying with rules.

In this report, *drivers* are factors that influence behaviours of actors and are significant in terms of pressures on the marine environment (Figure 1). The term *driver* (or *driving force*) can have different meanings in different contexts, leading to a risk of confusion.

In behavioural science, the term is used with a focus on individuals and the motives that produce drivers for them to achieve their goals and to act. Examples of internal drivers include personal convictions, values and knowledge about the environment. External drivers for individuals are for example linked to the prerequisites for acting in an environmentally friendly manner, economic factors and social norms (see e.g. Kollmuss & Agyeman, 2002; Gifford, 2013; Li et al., 2019).

Within the natural sciences, drivers can be virtually anything that affects a system. In other contexts, the term is often used to refer to large-scale societal phenomena. One example is the DPSIR (Driver–Pressure–State–Impact–Response) framework, which describes drivers as societal trends and goals that affect pressures on the environment (EEA, 1999). Another early model for drivers of environmental problems highlights factors such as the size and prosperity of the population (Ehrlich & Holdren, 1971).

1.1 THE AIM AND STRUCTURE OF THE REPORT

In this report, we review the concept of drivers and how they can be taken into account within marine management work to develop measures for a better marine environment. One important reason for this is to contribute to better methods for describing the causes of pressures and to provide data for developing policy instruments and measures.

The aim of the report is to illustrate existing knowledge about drivers, actors and behaviours of relevance to the marine environment around Sweden, and to link these to the concepts and processes that are currently used within marine environment management in Sweden and the EU. The ambition is that the report should provide agencies and researchers with both the motivation and the inspiration to map and analyse the societal systems where measures are needed in order to reduce the pressure on the marine environment.

We believe that an initial step for those who should address marine problems is to identify more closely the actors and behaviours that contribute to this pressure. The driver of actors can constitute both barriers and opportunities for changing behaviours and reducing the pressure on the marine environment. Linking drivers to actors and behaviours makes it possible to reach a level of detail that can be used for environmental management and the development of measures and policy instruments. Several examples of this are provided in the report, but we also deal with drivers used to analyse large-scale

1 A current list of activities from 2017 can be found in Appendix 2.

societal changes that affect environmental conditions.

Our starting point has been to use examples from studies of the Swedish marine environment and its management. Since only a limited number of studies in a Swedish marine environment could be identified, studies from other marine areas have also been used if deemed relevant.

In the following chapters, a description of the methods used in the work with this report is first provided (chapter 2). Examples are then used to show that there can be many different drivers, actors and behaviours behind a certain pressure on the marine environment (chapter 3). These examples also show that actors can affect each other in different respects. Chapter 4 describes methods for driver analyses to support devising measures and policy instruments. In chapter 5, we address how the concept of drivers is used in relation to large-scale societal phenomena, while chapter 6 reports on examples of studies on drivers that are relevant to the seas around Sweden and chapter 7 contains our conclusions.

2 METHODS

Information searches and mapping of relevant scientific articles and mission reports were carried out in several different ways.

A systematic search of the SCOPUS database for scientific studies of drivers and the marine environment was carried out using the following search terms: (driver OR driving) AND (society OR societal OR socio-economic OR socioeconomic OR social) AND marine AND environment. SCOPUS has excellent coverage of peer-reviewed scientific articles within natural, social and health sciences, but its coverage of so-called 'grey literature' is considerably poorer. This search produced a large number of documents – 515 documents for the period 1990–2020 – that included the above groups of search terms in their titles or summaries. Having read through the summaries of the 515 documents, 104 documents with relevance for marine environment management remained. However, for most of these 104 documents the link to society was fairly weak or superficial. The term *driver* is usually used to refer to one of the biological, chemical or physical impact factors mentioned in the Marine Strategy Framework Directive. In those cases where 'driver' refers to a phenomenon or process within society, it is almost exclusively a large-scale change such as population growth, urbanisation or economic growth. The limited search results led to us also using other search methods.

Open web searches (using the search terms 'driver', 'actors', 'behavio(u)r', 'marine environment', 'measures' and 'interventions') were used to find methods for identifying and analysing drivers and behaviours of actors of relevance for developing measures and policy instruments. These searches resulted in both mission reports and peer-reviewed scientific articles. Both types of literature have been used in chapter 4, in which methods for analysing drivers and behaviours of actors are presented.

A special review was carried out of documents about environmental problems from the EEA, HELCOM and Swedish agencies to see whether and how they link the pressures on the marine environment to drivers and actors within society. This part of the information search was based on studies that we or experts/colleagues we had contacted within academia and management deemed to be relevant.

Finally, additional relevant documents were identified by reviewing the reference lists in the documents identified via the original searches (the 'snowball method').

3 SYSTEMS OF ACTORS AND BEHAVIOURS

This chapter presents four cases, aiming to illustrate the diversity of actors whose behaviours can influence the pressures on the marine environment. Examples of drivers that can affect different behaviour of actors are also given for each of these cases.

3.1 EXAMPLE 1: PHARMACEUTICALS

In Sweden, more than 1,000 different active substances are used in approximately 7,600 different pharmaceuticals, and there are also a large number of excipients and packaging materials. Pharmaceuticals are designed to affect different processes in our bodies, and can thus also affect biological processes in many animals and plants. They are also designed to be chemically stable, meaning that they remain in the environment for long periods of time.[2] Environmentally hazardous substances can normally be banned, but this does not apply to pharmaceuticals under current Swedish and European regulations.

A major synthesis and status report on pharmaceuticals in the Baltic Sea was issued by UNESCO in partnership with HELCOM in 2017 (UNESCO and HELCOM, 2017). This report concluded that information about the occurrence, fate and effects of pharmaceuticals is generally scarce. It also reported the need for measures to counter environmental impacts in all stages from manufacturing to consumption and waste management, including treating wastewater and returning left-over medications.

Despite the general lack of information about pharmaceuticals in the environment, there are at least two well-documented global examples of pharmaceuticals used in Sweden having effects on both terrestrial and marine ecosystems. The anti-inflammatory diclofenac is believed to have almost eliminated the vulture population in Southeast Asia (Oaks et al., 2004), while the hormone 17a-ethinylestradiol is thought to make male fish more feminine at concentrations that can be measured below populated areas' wastewater treatment plants (Kidd et al., 2007). Anti-anxiety medications have also been reported to change the behaviour of fish. One widely discussed study claimed that oxazepam influences the behaviour of perch (boldness and feeding rate) (Brodin et al., 2013), although later studies in natural environments have shown weaker effects (Fahlman et al., 2020).

The abovementioned synthesis report from UNESCO and HELCOM focuses on pharmaceutical concentrations in the sea, but also includes a generic model of sources and flows of pharmaceuticals to the environment (Figure 2). This model starts with a household and then follows the flow of the pharmaceutical via their use and the disposal of unused medications.

2 https://www.naturvardsverket.se/Sa-mar-miljon/Manniska/Miljogifter/Organiska-miljogifter/Lakemedel/

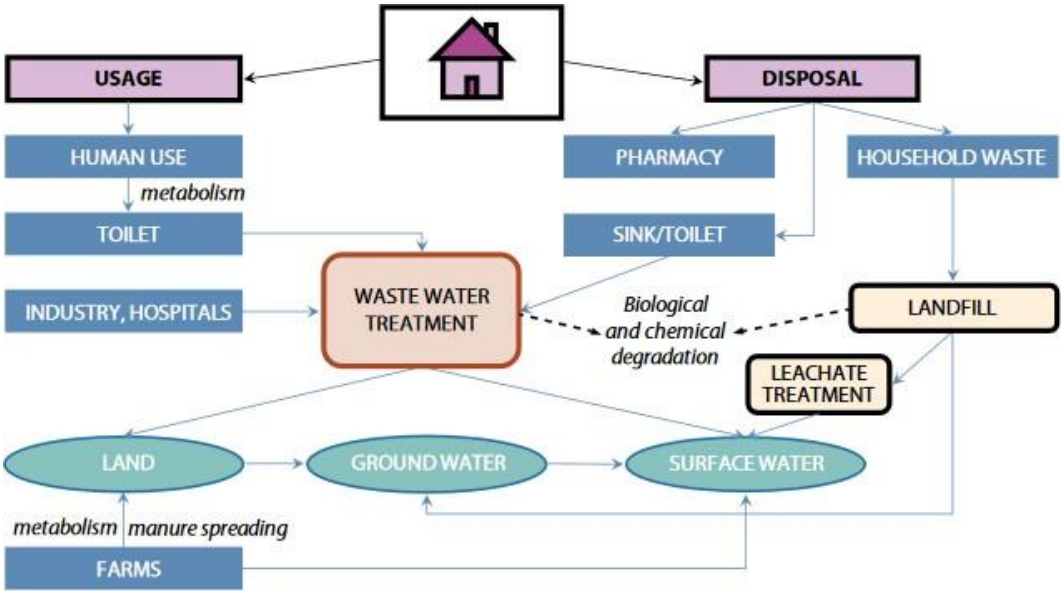

Figure 2. Main sources and flows of pharmaceuticals to the environment. Source: UNESCO & HELCOM (2017).

In order to concretise actors and behaviours that participate in pharmaceutical management, as well as possible effects on the marine environment, we have compiled a more detailed model in Figure 3. For many pharmaceuticals, there is data about concentrations in Swedish water and biota, and about effects on fish and mussels, for example, in laboratory experiments. However, we have been unable to find any studies that clarify the relevant actors and how they are linked to each other, and that identify their behaviours and drivers. We therefore only provide examples of possible actor chains and drivers here.

The model in Figure 3 shows that there are many different actors along the flow of pharmaceuticals through society to marine organisms that can be affected. Note that the group of actors in this figure is not exhaustive. For example, the model does not include either veterinary medication or returned pharmaceuticals. It is also possible to produce even more detailed models for individual pharmaceutical products.

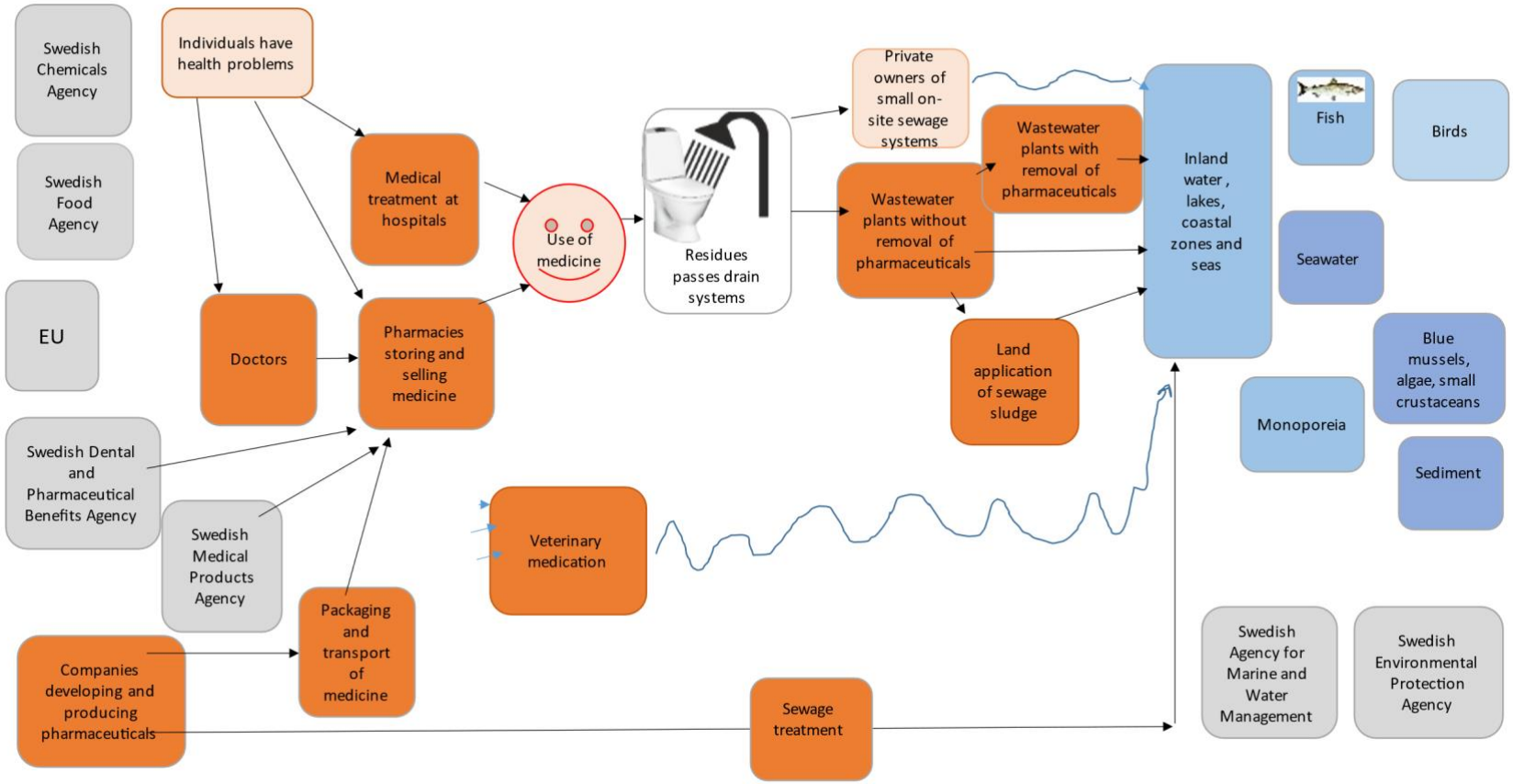

Figure 3. Model of actors involved in Swedish pharmaceutical management and groups of marine organisms that can be affected. The individual – represented as a circle in the centre – takes medicine, but many other actors, including authorities, have also been active earlier on. The arrows represent some form of flow (e.g. substance, action or information). The rust-coloured boxes represent professional actions, and the pale pink boxes are private individuals. The grey boxes represent authorities. Blue represents matrices or organisms in the marine environment in which pharmaceuticals or pharmaceutical residues have been identified.

The individual's desire to influence his or her own health for the better is, of course, an important driver behind the use of a pharmaceutical, but before the pharmaceutical is consumed various other actors have the opportunity to influence the flow of the pharmaceutical through society.

The production of pharmaceuticals largely occurs within a global market. For those actors who develop and manufacture pharmaceuticals, economics and business development are basic drivers. Once a pharmaceutical has been developed, it must then be approved by the Swedish Medical Products Agency before it can be used in Sweden.[3]

A doctor's drivers for prescribing a particular pharmaceutical are largely based on education and experience. Swedish doctors are supported by the so called 'Wise List' (Kloka Listan), which contains evidence-based recommendations for cost-effective pharmaceuticals for common illnesses.[4] This list is drawn up by Region Stockholm's Pharmaceutical Committee and its expert groups within various therapy areas. There is also FASS (Farmaceutiska Specialiteter i Sverige), a summary of pharmaceutical facts issued by Sweden's industry association for pharmaceutical research companies,[5] which provides information about the effects and side-effects of pharmaceuticals on people. The Dental and Pharmaceutical Benefits Agency decides which pharmaceuticals should be included in the pharmaceutical benefits, also referred to as high-cost protection measures.

Environmental effects do not yet play a central role in the choice of pharmaceuticals. Even if these effects are known for a certain substance or pharmaceutical, this is not an established criterion for choosing not to prescribe a pharmaceutical. However, the Swedish Medical Products Agency has recently (autumn 2019) established a new unit, the Swedish Knowledge Center on Pharmaceuticals in the Environment, as a national platform for dialogue and collaboration to help increase and disseminate knowledge about pharmaceuticals in the environment.

The quantities of pharmaceuticals or pharmaceutical residues that eventually reach aquatic environments depend on how the wastewater treatment plant is designed and operated. Since many common pharmaceuticals currently pass relatively unhindered through wastewater treatment plants (Svahn & Björklund, 2018), significant investments may be required in order to reduce the pressure on the marine environment through improved wastewater treatment. The pace of development may therefore largely be determined by actors within Swedish municipalities and their considerations in view of other needs.

3.2 EXAMPLE 2: SHIPPING

Shipping is an activity that directly influences the marine environment. Just like pharmaceuticals, shipping plays a crucial role in society and hence it is impossible to eliminate all sea transport in order to reduce the pressures on the marine environment.

3 https://www.lakemedelsverket.se/sv/tillstand-godkannande-och-kontroll/vad-ar-ett-lakemedel
4 See http://klokalistan2.janusinfo.se/20201/
5 https://www.fass.se/LIF/startpage

However, it may be desirable in many cases to replace the mode of transport for transporting both goods and passengers, or to reduce the need for transport. For each mode of transport, it is therefore important to identify specific pressures, what controls them, and the conditions required to achieve a better situation.

Shipping contributes towards several different types of pressure on the marine environment, via both air emissions and direct impact on the marine environment (Figure 4).

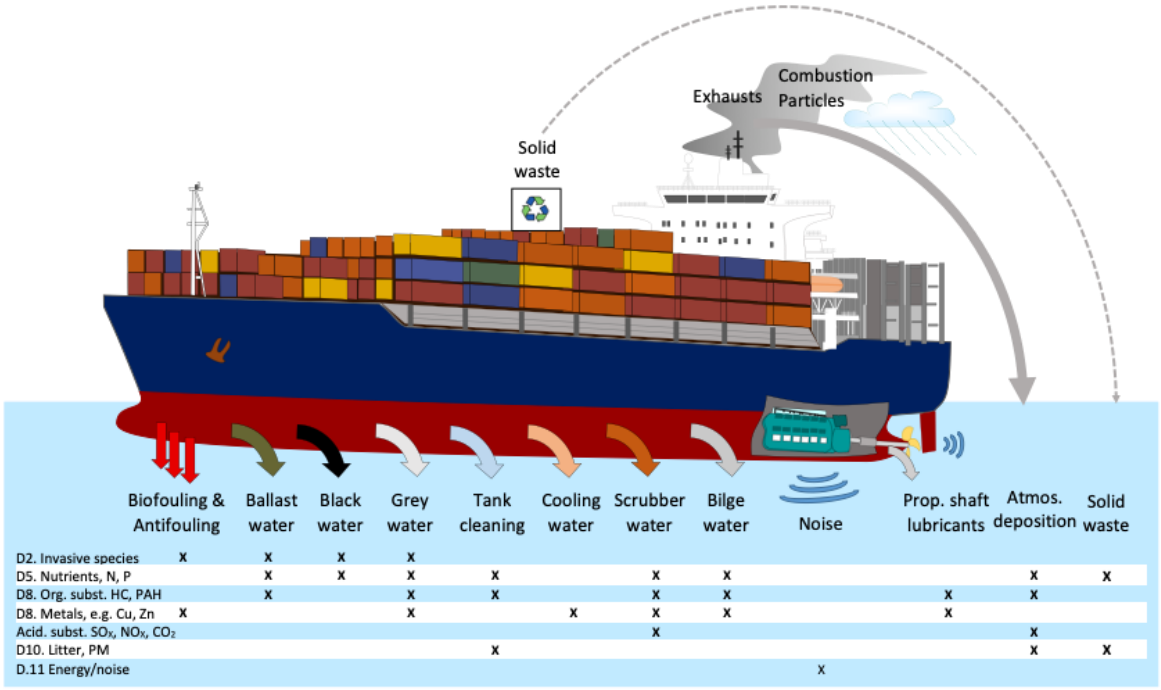

Figure 4. Overview of emissions from shipping to the sea and air, and the descriptors in the EU's MSFD that can be linked to emissions and that are used to determine the marine environment's status. Source: Hassellöv et al. (2019).

Even though the vessel constitutes a unit, several different actors can indirectly influence the pressure on the marine environment. For example, an analysis of shipping between China and the US showed that refuse made up 15 percent of the flow of goods in both directions. This means that both developing new logistics systems and the general globalisation of goods flows can contribute to the scope of environmental problems (Liu et al., 2019).

Another example illustrates the importance of analysing actors' drivers when introducing new regulations for activities with an environmental impact. Shipping's use of heavy fuel oil with high sulphur content has long caused significant air pollution, and has contributed towards the acidification of both terrestrial and aquatic environments. A global regulation regarding shipping's sulphur emissions to air has therefore been

introduced by the International Maritime Organization (IMO). However, this regulation does not include any restrictions on direct emissions to water. This has enabled ships to continue using fuel with high sulphur content if a scrubber is installed, whereby air emissions are ‘washed’ with a fine spray of water so that sulphur, pollutants and nutrients are collected in the washing water. The simplest and most common type of scrubber (open loop) releases the washing water directly into the sea. There are also scrubbers that produce much lower volumes of washing water (closed loop) and usually separate out residual products that can be left to be dealt with at ports.

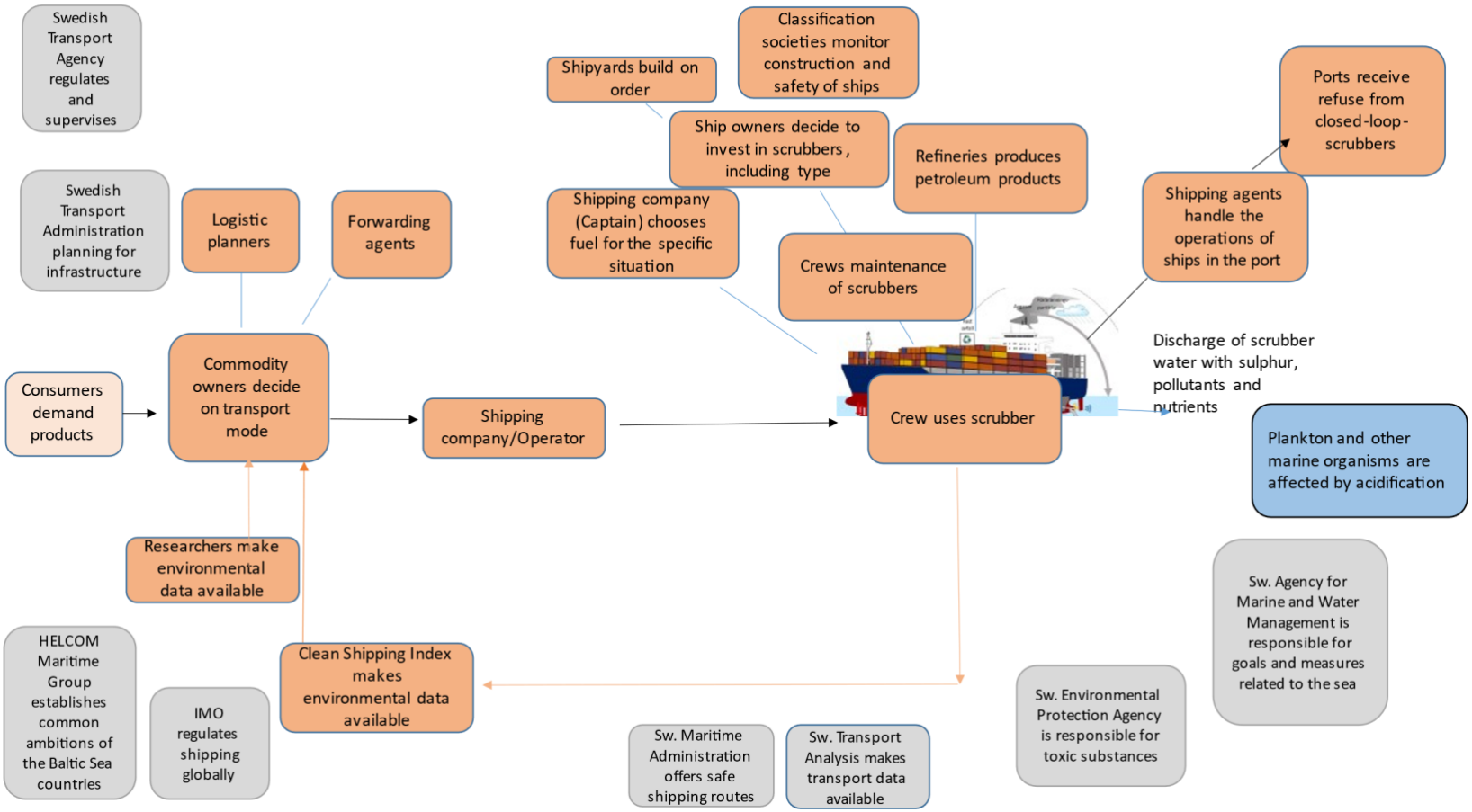

Figure 5. Some of the actors in the maritime value chain that deal with measures affecting scrubber emissions and thus marine ecosystems. The arrows represent some form of flow (e.g. substance, action or information), and are only examples of possible flows in this figure. The stand-alone boxes also have links to the physical flows. The rust-coloured boxes represent professional actions, and the pale pink boxes are private individuals. The grey boxes represent Swedish authorities and international organisations that influence shipping, while the blue box represents the marine ecosystem.

When the global IMO regulation on sulphur emissions from shipping was introduced, the idea was that shipping would switch to fuels with lower sulphur content. However, many shipping companies chose to install scrubbers instead, which certainly reduced emissions to air but also increased direct emissions to the sea. The economic driver to continue using cheap bunker fuel instead of fuel with a low sulphur content was thus stronger under the prevailing circumstances than the driver to protect the marine environment. Another way of looking at this is that shipping companies' trust in research information about the negative effects of scrubber water on the marine environment was not strong enough.

3.3 EXAMPLE 3: EUTROPHICATION VIA PHOSPHORUS LOAD

An excessive flow of the nutrients nitrogen and phosphorus from the land to the sea has resulted in serious eutrophication of the Baltic Sea. This example (which is limited to phosphorus – see Figure 6) shows that a large number of human activities in Sweden contributes to the pressures on the marine environment. Many actors are thereby also involved.

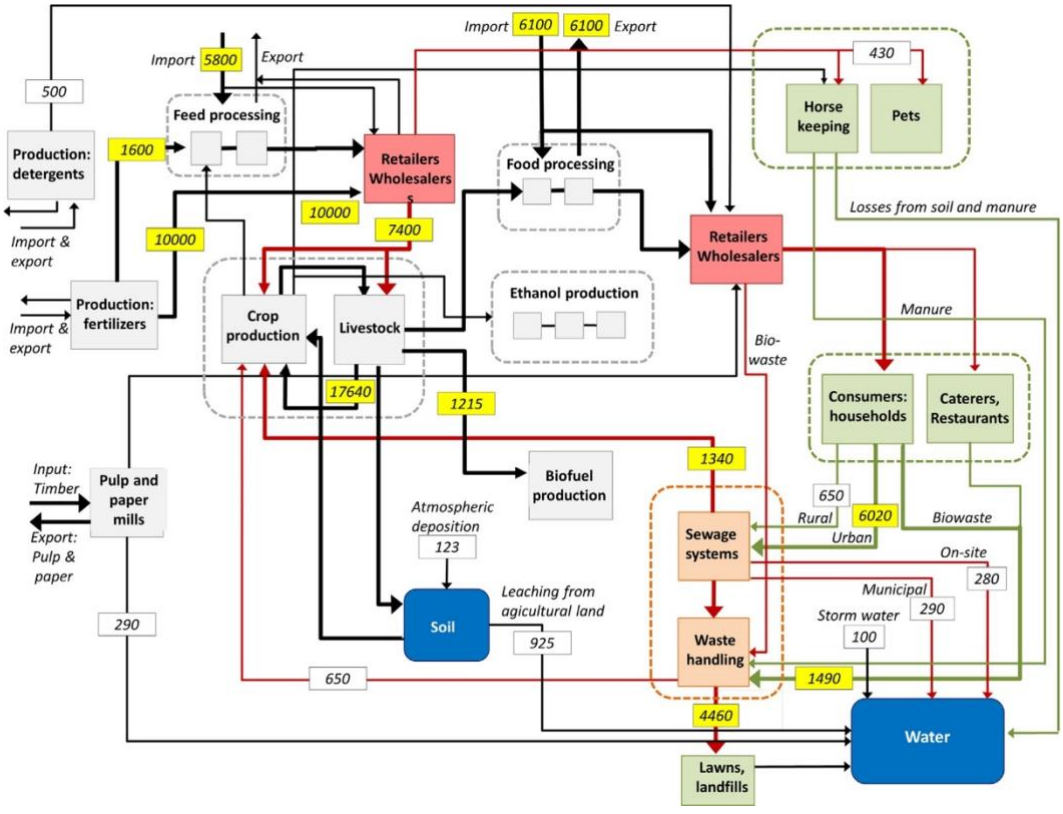

Figure 6. Flowchart for phosphorus in Swedish society. Grey boxes are production, green boxes are consumption/private activities, pink boxes are commerce and rust-coloured

boxes are sewage/waste. Data from Linderholm and Mattsson (2013) and Ejhed et al. (2011).Source: Grimvall et al. 2018.

By looking at elements of the flow more closely and starting from a consumer viewpoint, it is possible to identify different actors and groups of actors who are involved (Figure 7). Here, we show a value chain for beef from a previously published report (Grimvall et al., 2018).

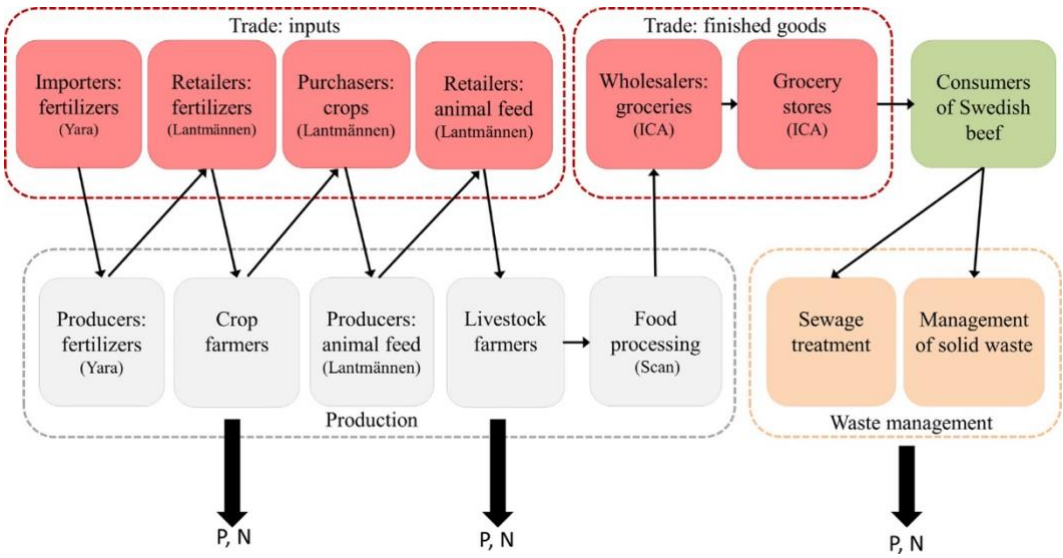

Figure 7. Groups of actors in the goods chain for beef. Source: Grimvall et al. 2018.

The consumer's choice to eat beef may be affected by factors as wide-ranging as hunger, taste, point of purchase, ability to plan, finances, access to accompaniments, alternative dishes, knowledge about the environmental impact, and social norms. What can be purchased without great time pressure is also an important aspect, and here the local retailer plays an important role. The retailer's drivers are to earn money and make a profit, but there are also many other ambitions. Earlier on in the goods chain, there are many other opportunities to act in a way that reduces phosphorus leaching during beef production. Different actors also influence each other. Through their actions, the individual farmer and different industries (agriculture, the food industry, commerce, etc.) can both support and block the right conditions for other actors to act in a more environmentally friendly manner.

3.4 EXAMPLE 4: FISHING

Large-scale fishing, combined with the impact on fish's environments from other sectors of society, have meant that a number of species and populations in the seas around Sweden are severely affected. Commercial cod, herring and sprat fishing are regulated by the EU within the framework of the Common Fisheries Policy, while other commercial fishing and leisure fishing are regulated and have quotas set by individual member states.

It is also worth noting that only 17 percent of the reported Swedish-caught fish from waters around Sweden (a total of 211,000 tonnes per year) go directly to Swedish consumers. The largest proportion of these fish are sold in the international feed market (approximately 163,000 tonnes per year), and are used in fish farming, at mink farms, etc. (Sundblad et al., 2020). Figure 8 provides an overview of actors who affect fishing.

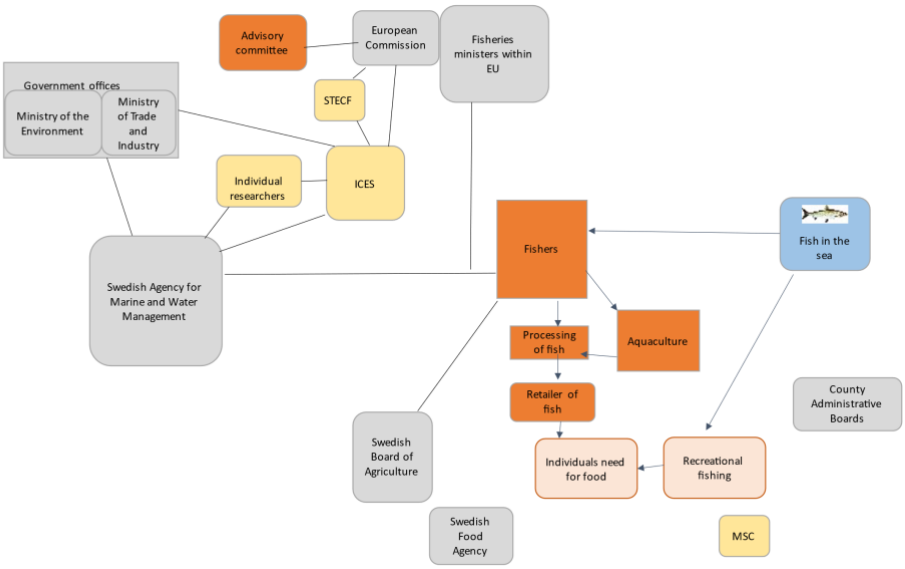

Figure 8. Overview of some of the actors involved in decisions that affect fishing. Arrows indicate flows of fish, while lines represent other links. The grey boxes represent Swedish authorities and EU bodies, the orange boxes are professional actors, and the yellow boxes are information actors.

Commercial fishers have basic drivers for fishing, such as making a living and contributing towards the food supply within surrounding society. However, commercial fishing is governed to a high degree via both EU and Swedish regulations by external factors such as subsidies, decisions on quotas, knowledge, information and other tools from many different actors. For example, the European Commission asks the ICES each year for scientific advice regarding stocks and suitable fishing quotas for the major commercial fish species in the Baltic Sea and other sea basins. The advice from the ICES is then discussed by the European Commission's STECF advisory committee, which consists of organisations for actors within fishing. Finally, it is the EU's fishing ministers who make joint decisions on total quotas for cod, herring and sprat per sea basin and allocate these by nation. Within Sweden, the quotas established by the EU are allocated in accordance with Swedish rules. The Swedish Agency for Marine and Water Management also has a general remit to work towards sustainable management of the entire fishery resource, while the Swedish Board of Agriculture is responsible for developing the

fishing industry and the county administrative boards deal with regional fishery conservation measures. This allocation of responsibility and control creates both opportunities and barriers for the authorities to act alone or together.

More detailed discussions about the behaviours of fishers can be found in articles about conditions within the fishing industry. One frequently cited article highlights five factors (drivers) affecting fishers' rule compliance: economic gains, sanctions, compatibility between regulations and fishing practices, the efficacy of imposed regulations and the norms of the individual fisher (Nielsen & Mathiesen, 2003). A recently published thesis shows how small-scale fishing in the Baltic Sea has been formed by regulations and socioeconomic conditions within the surrounding society (Björkvik, 2020).

Fish consumers are also affected by a number of external factors and actors. Information from the Swedish Food Agency about how fat Baltic fish species such as Baltic herring and salmon contain environmental toxins recommends consumers not to eat these fish. Retailers' drivers to sell fish, earn money and also demonstrate a sustainability profile may lead to them supplying only MSC-labelled fish, involving a third party certifying that the fish has met certain sustainability criteria. Non-MSC-certified fish cannot therefore reach the consumer, and is instead sold on the international feed market. As a result, the consumer's opportunities to influence which fish are caught – and thereby support an improved marine environment – are limited.

3.5 COMMON FEATURES OF THE EXAMPLES

The examples above show that for every pressure on the marine environment, there are a number of actors who can influence the size of the final pressure. Every actor has its own drivers and barriers, which form the basis for the behaviours that affect the environment. We can also note that the knowledge about actors and their drivers is fragmented and incomplete within the areas that we have chosen to use as examples, despite the fact that these areas are important for the Swedish marine environment.

To identify the actors and behaviours that should be included in data to support developing policy instruments and measures, it is useful to have a systematic model. A brief version of such a structure was produced in the example on eutrophication. Chapter 4 provides several examples of how actors, behaviours and their drivers can be identified, and how this information can be used.

4 DRIVERS AND BARRIERS FOR BEHAVIOURS OF ACTORS

We have studied articles and reports linked to the marine environment which describe methods for identifying the factors that constitute drivers or barriers for behaviours of actors. Some of these methods go all the way from an analysis of an environmental problem to recommending policy instruments,[6] while others are limited to some steps of a full analysis.

A common feature in all studied literature is the assumption that changed behaviours are essential for reducing environmental pressure. As a result, the theoretical framework is largely based on behavioural science. We have gone through both peer-reviewed articles and studies that are only available in so-called 'grey literature'. The latter type of sources was included because analyses of drivers and barriers as support for developing policy instruments are often carried out as commissioned projects, for example by authorities. The examples provided in this chapter illustrate the type of results that can be achieved by analysing actors, behaviours and drivers.

Methods that intend to support development of policy instruments usually include the following steps: 1) basic information gathering about the environmental problem and relevant decision-making structures, 2) an actor analysis and, in the case of environmental problems linked to a product, a life-cycle analysis, 3) identifying the drivers and barriers that make actors behave in a manner that is harmful to the environment, 4) designing and testing policy instruments, and 5) evaluating the effect of policy instruments.

The common steps are briefly described here, with the greatest emphasis on step 3, identifying drivers. The text refers to 'environmental problems' in a general sense. However, it should be noted that analyses of drivers tend to be directed towards specific aspects such as 'illegal fishing', 'littering in marine protected areas' or 'plastic packaging materials' in marine environments. A narrow definition is necessary, since analysing actors and drivers is strongly context-bound, as shown in chapter 3.

4.1 BASIC INFORMATION GATHERING ABOUT THE ENVIRONMENTAL PROBLEM

A prerequisite for developing policy instruments is to map the environmental problem that needs to be addressed, including both the extent of the problem and its direct causes. This will typically include analysing the environmental status, the size and geographic extent of relevant pressures and their pathways to the environment, and identifying which activities that contribute to these pressures as well as estimating their relative

6 As defined by the Swedish Environmental Protection Agency, policy instruments aim to change how actors choose to make decisions, so that individuals and businesses carry out measures that improve the environment. The instruments are normally categorised as administrative (legislation and regulations), economic (taxes and subsidies) or information (campaigns and labelling) (Swedish Environmental Protection Agency, 2020).

contributions.

Mapping the regulations that influence the environmental problem in question is also often included in the studied methods. Such a mapping can be used to discover any conflicts between relevant regulations, and as a starting point for identifying actors within the decision-making and management structure that can contribute to changed behaviours (see step 2) (Battista et al., 2018; Cole et al., 2019; Matthews & Stretz, 2019). The process of gathering this type of information is usually based on literature reviews and public sources.

4.2 ACTOR ANALYSIS

Analyses of drivers are often based on mapping actors with a direct or indirect impact on the environmental problem. Actor analyses can, for example, be divided up by markets, management structures, decision-making structures and civil society, and thereby represent how decisions by corporate, public as well as private objectives affect the environment (Reddy et al., 2017). Decisions within the governance and marine management structure are important, since they can control and provide conditions for changed behaviours of both businesses and individuals. In addition, the behaviours of individual employees within the marine management structure can also affect decisions, thereby affecting environmental conditions (Beunen & Pattersson, 2019; Hegger et al., 2020).

When the environmental problem is linked to products, the actor analysis is often preceded by a life-cycle assessment of the product. Such analysis assesses specific environmental effects of production stages, consumption and handling of residual products, and the actors are also identified in each stage (Grimvall et al., 2018; Cole et al., 2019).

In certain cases, the analysis of actors also gives attention to and covers stakeholders which includes additional groups than actors (Matthews & Stretz, 2019), such as groups affected by but not contributing to the environmental problem. It is highly relevant to include a broad group of stakeholders in the process, but it is primarily the behaviours of actors that need to be changed in order to reduce pressure on the environment.

Two examples of actor analyses are given here.

Grimvall et al. (2018) identified the following relevant groups of actors along the flow of phosphorus to the Baltic Sea that can be linked to the consumption of beef (see also Figure 8):

- producers, importers, retailers and purchasers of nutrients
- farmers and cattle breeders
- food processing activities
- consumers of beef

- waste management and wastewater treatment

Cole et al. (2019) investigated the groups of actors that led to fishing gear ending up as marine litter, with the following results:

- manufacturers of fishing gear components and commercial fishing gear
- retailers of fishing gear
- the fishing industry and fishers
- port authorities and waste management operators

All these actors can affect the marine environment through the decisions they make and should therefore be included in analyses in order to identify the most suitable policy instruments for reducing environmental impact.

4.3 DRIVER ANALYSIS OF FACTORS AFFECTING BEHAVIOURS

The starting point for analysing factors that affect behaviours is to identify the drivers and barriers that lead to actors contributing towards an environmental problem, usually by identifying an undesirable behaviour that must be changed, or alternatively a desirable behaviour, in order to achieve agreed objectives. In behavioural science, the term drivers is used with a focus on the individual and the motives for the individual to achieve its goals and to act. There are several different models and associated factors to explain behaviours that affect the environment. Box 1 contains examples of factors that may be relevant to consider when designing policy instruments.

Box 1. Factors affecting environmentally friendly behaviour

There are many ways to define and categorise the barriers and drivers that can counteract or contribute to a more environmentally friendly behaviour. Here are some examples of factors, several of which appear in the studies on the marine environment reported on in this chapter. For more examples and categorisations of factors that affect behaviours in relation to environmental issues, see e.g. Kollmuss & Agyeman (2002), Gifford (2013) or Li at al. (2019).

External factors:

- Institutional factors: prerequisites for acting in an environmentally friendly manner, such as access to public transport or waste management.
- Economic factors: e.g. income or financial incentives.
- Social and cultural norms: implied norms from the individual's social net.

Internal factors:

- Motivation: The drive theory of motivation is based on individuals wanting to

maintain an internal state of balance (Hull, 1943). When equilibrium is broken (state of internal tension), drivers are generated which motivate an individual to reduce the tension. More recent research has shown that other concepts, such as incentive and expectation, play important roles when it comes to motivation.

- Knowledge: e.g. about the consequences of environmental degradation and the available options.
- Beliefs: a personal conviction of one's own knowledge of the environment.
- Values: Personal values about what is important in life, which is affected by both social norms and close relationship (e.g. family, neighbours, colleagues).
- Attitudes: a positive or negative approach to something, such as sorting waste or buying environmentally friendly products.
- Trust: for example trust in other people and their approach towards the environment, or confidence in society's institutions.

We highlight these types of factors in this report because an understanding of their influence is central to change behaviours through various policy instruments. Some results from existing studies are provided below to give examples of behaviours, drivers and barriers that have been identified in relation to marine environment problems.

For example, the following undesirable behaviours were identified in a review of factors behind illegal fishing, (Battista et al., 2018):

- fishing without a permit
- fishing in restricted areas
- fishing for protected species
- fishing with illegal gear
- failing to report catches

Undesirable behaviours can often be identified through literature studies and interviews. It can be noted that it is often recommended to carry out analyses in a different order than outlined here, in other words first identifying the behaviours that cause an environmental problem and taking these as a starting point from which to identify relevant actors (Martin et al., 2017; Reddy et al., 2017). With this approach, the actor analysis, currently outlined as step 2, will likely be less extensive.

The literature reported on here takes behavioural science theory as a basis for analysing drivers. Several peer-reviewed articles emphasize that drivers should be analysed based

on established theoretical frameworks that encompass testable hypotheses regarding the type of drivers underlying a particular behaviour (Martin et al., 2017; Reddy et al., 2017; Battista et al., 2018). Examples of highlighted theories include the Theory of Planned Behaviour (TPB) and the Value-Belief-Norm Theory (VBN[7]). There are also examples in which several behaviour models have been combined, for example to study drivers behind compliance with rules for leisure fishing (Thomas et al., 2016). Such analyses can be based on interviews or survey studies among the identified actors. However, when theoretical models are taken as a starting point, extensive knowledge about suitable models, developing specially adapted surveys, and systematic analysis of collated data are required. This approach thus tends to be rather resource demanding and organised as research projects.

In the studied 'grey literature', the method is less clearly linked to theories and instead follows a more pragmatic approach in which discussions with actors during workshops aim to identify drivers, and expert judgements are used to interpret the results.

Common types of factors underlying undesirable behaviour include actors' own objectives, convictions, preferences, costs, norms, lack of information or the rules affecting the environmental problem (Reddy et al., 2017; Battista et al., 2018).

In a study with the intention of recommending policy instruments to reduce the consequences of lost fishing gear in Scottish waters, the following more specific drivers and barriers were identified (Cole et al., 2019):

- high quality gear, which is less likely to be lost or is partly biodegradable, is expensive to produce and buy
- there is no value in retrieving lost gear
- recovering lost gear means losing time for fishing, and can also be dangerous
- a lack of information about the consequences of ghost gear
- a tradition of throwing waste into the sea
- a lack of knowledge about how waste can be left at ports

Many drivers and barriers could thus be linked to the users of fishing gear, as well as the production of fishing gear and processing of scrapped fishing gear (Cole et al., 2019). The authors also emphasise the importance of taking a systems perspective in the analysis, highlighting that increased producer responsibility can be an important policy instrument.

The previously mentioned example of illegal fishing (Battista et al., 2018) categorised drivers based on an individual perspective: self-interest, perceptions and convictions, and a lack of information. The more specific drivers identified within each category were linked to factors such as a desire to increase income or status, a lack of trust in the

7 Those who are interested in studying these theories in greater depth are referred to Ajzen (1991) and Fishbein & Ajzen (2010) (TPB), as well as Stern (2000) (VBN).

regulations or a lack of understanding of the consequences of illegal fishing.

4.4 DESIGNING AND TESTING POLICY INSTRUMENTS

We will not go into specific methods for devising policy instruments here, but we note that behavioural research is central in terms of changing the behaviour of individuals in a desired direction. In simple terms, cognitive processes of significance for individuals' decisions can be described as either intuitive and automatic or rational and reason-based (Kahneman, 2003; Ariely, 2008). In certain contexts, policy instruments can be designed to encourage one of these processes or the other.

For example, Reddy et al. (2017) advocate how different types of policy instruments can be devised depending on whether the identified undesirable behaviour is governed by reasoning or intuition. If behaviours and decisions are based on reasoning, policy instruments are suggested in order to increase awareness of the environmental problem or to introduce incentives that encourage desirable behaviours. Such incentives can, for example, be based on financial instruments, regulations, social norms or factors that speak to the individuals' personal values and norms. If, on the other hand, the behaviours are based on intuition, measures that aim to 'nudge' the individual in the right direction (Thaler & Sunsten, 2008; Gravert & Carlsson, 2019), i.e. to facilitate the desirable behaviour, are recommended. A classic example is placing waste bins in carefully selected locations where litter is dropped, making it easy to do the right thing.

Another example is a study of compliance with rules for leisure fishing that focuses on identifying drivers behind undesirable behaviour. The results showed that the most important drivers for compliance with rules were social norms, particularly what other fishers are assumed to do (in this case, the assumption that other fishers follow the rules). In view of these results, it was suggested that measures to increase compliance with rules should be targeted at encouraging people to follow the behaviour of others, rather than increasing control and monitoring of leisure fishing (Thomas et al., 2016).

Lack of knowledge is often singled out as a barrier resulting in undesirable behaviour, and information campaigns are commonly used tools within environmental management. Information is essential, but information campaigns are often an ineffective policy instrument if they are not targeted towards specific factors of significance for behaviours, for example in order to change attitudes or reinforce social norms (Kollmuss & Agyeman, 2002; Steg & Vlek, 2009; Gifford, 2013).

Many studies recommend testing policy instruments before implementing them, if possible through pilot testing. Alternatively, they can be based on hypothetical scenarios that have been identified by central actors as having an influence on the environmental problem in question.

4.5 EVALUATING POLICY INSTRUMENTS

Finally, all the studied methods attach great importance to evaluating policy instruments once implemented. This involves both estimating whether the undesirable behaviour has

been changed and measuring the improvement in environmental conditions. One way of estimating changes at an early stage is to analyse whether the conditions required for changed behaviours have been introduced, for example whether decisions have been made that are expected to contribute to changed behaviours (regulations, incentives) or that the capacity to deal with waste products has increased. In line with adaptive management, the results of such follow-up evaluations should form the basis for adjusting the policy instruments.

4.6 REFLECTION

We have presented methods that are used to support development of policy instruments that address marine environment problems. Although only six of the reviewed studies were based on systematic methods, several similarities can be noted.

First, the steps included in the analyses are based on established methods and generate information about underlying causes of environmental problems, involving pressures, actors and drivers. In addition, they are all based on the understanding that reduced pressure on the environment requires changed behaviours. Second, the studies tend to focus on behaviours of individuals. Although this means that the studies pay less attention to the drivers behind decisions made by businesses or authorities, the results still reflect the behaviours of individuals within these groups, such as fishers or inspectors and professionals at relevant authorities.

While the methods are largely based on behavioural science, the analyses require an interdisciplinary approach in which information about both environmental problems and society need to be gathered and interpreted. The methods also emphasize the importance of interaction with actors during the process, both to identify drivers and to create legitimacy for future policy instruments.

5 LARGE-SCALE SOCIETAL PHENOMENA AS DRIVERS

This chapter shows how large-scale societal phenomena can constitute drivers for marine environment problems. In section 5.1, we discuss the DPSIR framework and its variants. Section 5.2 provides examples of major societal trends of significance for the environment as identified by the European Environmental Agency (EEA). Section 5.3 gives other more specific examples of societal trends. In section 5.4, we clarify how the term *activities*, as used in the Marine Strategy Framework Directive, can be linked to the DPSIR framework and actor analyses as described in chapters 3 and 4.

5.1 DRIVERS IN THE DPSIR FRAMEWORK AND ITS VARIANTS

The first framework with the intention of creating a general terminology for describing the link between human activities, environmental impact and societal measures was the P-S-R (Pressure-State-Response) scheme, as applied by the OECD (OECD, 1993). This framework was then further developed by the European Environmental Agency (EEA) with the addition of the nodes D (Driving force) and I (Impacts), resulting in the current DPSIR framework (EEA, 1999, 2003). The intention was to develop a set of indicators to communicate environmental conditions, to provide support for development of policies and priority setting, and to be able to evaluate the effect of measures and policies. In the EEA's application of the framework, driving forces were defined as population growth and individuals' fundamental needs, which lead to changes in production and consumption, and in turn to changes in pressure on the environment. In a contemporary publication by the European Commission, driving forces were described as trends within sectors such as energy, transport and agriculture (EC, 1999). Since then, both the DPSIR framework and the interpretation of its nodes have been developed as described in a number of overview articles (e.g. Gari et al., 2015; Patricio et al., 2016).

BPSIR (Sundblad et al., 2014) is a more recent adaptation of the DPSIR framework that clarifies *what* within society creates pressure on the marine environment. Here, drivers have been concretised by replacing D with B (for Behaviour). This brings greater awareness of the fact that there are behaviours by actors that need to be changed in order to improve the marine environment. Identifying actors and pressures makes it easier to map the available alternatives for reducing the pressure in question. The BPSIR framework has been used in Sweden together with network and actor analyses to identify actors and behaviours of significance for reducing eutrophication in the Baltic Sea (Vallin et al., 2016).

DAPSI(W)R(M), as described by Elliott et al. (2017), is another of many adaptations of the DPSIR framework. Here, attempts have instead been made to clarify the links between the original nodes by introducing additional components in the framework. D (Driver) is defined as basic human needs, such as food, shelter, security and goods, while A stands for Activities carried out within society in order to produce goods and services.

W stands for Welfare, and M for Measures. Basic human needs are defined in accordance with Maslow's hierarchy of needs (Maslow, 1943). Some of these needs are essential for survival, while others enable individuals to develop their self-actualisation (see Appendix 1).

The DPSIR framework is not explicitly mentioned in the EU's Marine Strategy Framework Directive, but is utilised in guidance documents to describe how the Directive's various stages are linked to each other. In a Commission Staff Working Document, the nodes are adapted and defined according to the DAPSES-MMM (Drivers-Activities-Pressures-State-Ecosystem Services: Management, Measures and Monitoring) framework. Drivers are described as aspects of human society which lead to the use of marine resources or to activities in the marine environment. Examples of drivers include social and economic societal goals (such as health, well-being and food supply), as well as policies and governance systems (subsidies and regulations). Activities are distinguished from drivers with the reasoning that activities are consequences of drivers, and because activities that affect the sea must be quantified and reported in accordance with the Marine Strategy Framework Directive (EC, 2020).

5.2 MAJOR SOCIETAL TRENDS OF SIGNIFICANCE FOR THE ENVIRONMENT

The European Environmental Agency, which introduced *driving forces* to the DPSIR framework (EEA, 1999), has continued to develop this concept. For example, the agency has used it to analyse and evaluate large-scale trends that may have consequences for Europe's environment and sustainability. In a report from 2019 six thematic areas are listed as the main drivers of changes that have affected – and continue to affect – both land and marine environments and the opportunities for future sustainable development (EEA, 2019a):

- A growing, urbanising and migrating global population: The global population is expected to increase, as is urbanisation, placing e.g. greater demands on infrastructure in order to reduce pressure on the environment from cities.
- Climate change and environmental degradation worldwide: In addition to the projected impact on the environment, climate change is expected to result in migration of people, both internationally and to cities.
- Increasing scarcity of and global competition for resources: Global energy consumption and the use of natural resources are expected to continue to increase.
- Accelerating technological change and convergence: Technical development has contributed towards unsustainable exploitation of environmental resources, but can also contribute to reduced impact in the future.
- Power shifts in the global economy and geopolitical landscape: The general growth in prosperity is expected to increase demand for natural resources even more, and geopolitical changes can affect the global market and thus also the

environment, both in Europe and in the rest of the world.

- Diversifying values, lifestyles and governance approaches: Some of these aspects are expected to have positive effects on the environment, while others will have negative effects. Due to the links between economic markets, people and the environment, the importance of intergovernmental agreements is expected to grow in future, and new governance approaches are expected to emerge out of necessity.

The six thematic areas are further divided in different types of trends (Box 2). More detailed examples of what these trends currently indicate can be found in EEA 2019a.

Box 2. Type of trends falling within the six thematic areas

- global megatrends – long-term trends, but with potentially significant impacts on the whole world within the next 10–15 years,
- regional trends – medium- to long-term trends that are characteristic of Europe, but that do not necessarily affect the rest of the world,
- emerging trends – rapidly emerging trends that are not yet well established, but may become established as global and regional trends in the future,
- 'wild cards' – changes that are unlikely, but that could affect future development if they were to occur (such as the impact of microplastics).

There are many examples of indicators that describe social and economic trends in Europe, such as gross national product, energy consumption, transport, extraction of natural resources, consumption of nutrients and tourism (EEA, 2019b). The EEA and Eionet (European Environment Information and Observation Network) have also developed guidance for identifying trends and indicators that can be applied to assess future environmental impact on a national level (EEA, 2017). This method can for example be used to evaluate whether national policies and strategic objectives are appropriate in relation to anticipated future changes.

Drivers in the form of large-scale trends can explain some of the changes that have occurred in the Baltic Sea area, and that have resulted in today's unsustainable use and pressure (HELCOM, 2018). Analysing trends and projections of the type of large-scale trends described above also provides information about anticipated future pressures on the environment in the case that current patterns and societal development continue. Knowledge of these trends and their consequences are thus important to provide opportunities for decision-makers to change the direction of societal development.

Today's globalisation also means that, in many cases, decisions and changes to reduce pressure on the Baltic Sea are made at European or global level, or at a sea basin level. Sustainable use of resources will require changes to production and consumption patterns at global level (EEA, 2019a, 2019b).

5.3 OTHER EXAMPLES OF STUDIES ON LARGE-SCALE SOCIETAL PHENOMENA

A recently published study (Bryhn et al., 2020) reviews how different activities within society affect Swedish marine areas, the economic value they generate, and how dependent these activities are on the sea's ecosystem services. For example, it is emphasised that both commercial fishing and coastal tourism are strongly dependent on the sea's ecosystem services, while tourism – in relation to its economic value – has considerably less environmental impact. The study is based on the DAPSIR framework and its further development, DAPSI(W)R(M). This means that drivers are defined as large-scale or overall societal changes that affect entire societal sectors' interactions with the sea. Individual actors and the underlying drivers that affect their behaviour are not dealt with in this study.

Another study (Scharin et al., 2016), which is also based on the DAPSIR and DAPSI(W)R(M) frameworks, and which affects Swedish sea areas, emphasises the importance of marine environment management being characterised by an overall perspective. Understanding both processes and functions in ecosystems and how people's behaviour and actions affect the interaction between people and the sea is a major challenge. It is also important that marine environment management addresses different spatial scales and time scales. As in EEA 2019, the authors emphasise that the development of drivers, activities and pressures on the Baltic Sea is not only affected by local or national conditions, but is also determined to a large extent by global trends within agriculture and the transport sector.

In a study of internationally observed regime shifts in marine ecosystems, Hicks et al. (2016) state that monitoring changes within society can increase the opportunity to predict regime shifts and to react to collapsing ecosystems in time. Technological advances, shifts in demand for products from the sea and changed policies are a few examples of changes that the article's authors mention as drivers that should be monitored. However, the article does not go into great depth regarding actors, their behaviours and underlying drivers.

The IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services), which also produces knowledge reports and relevant tools and methods for preserving biological diversity and ecosystem services, emphasises the importance of large-scale drivers. Here, a distinction is drawn between indirect drivers (such as institutions and management systems) and direct drivers, which can be both anthropogenic (e.g. change in habitats) and from nature (e.g. volcanic eruptions) (Diaz et al., 2015). The IPBES definition of indirect drivers corresponds most closely to societal

drivers and how the single term ‘driver' is typically used in the DPSIR framework while the term ‘direct drivers’ corresponds to pressures.

5.4 THE CONCEPT OF ACTIVITIES WITHIN THE MARINE STRATEGY FRAMEWORK DIRECTIVE AND ITS LINK TO DPSIR AND ACTOR ANALYSES

The EU's Marine Strategy Framework Directive does not mention and gives no guidance on how to analyse drivers. However, it does include a list of activities that contributes to a direct pressure on the marine environment through the supply of substances, the extraction of resources or the disruption of living organisms and habitats (2008/56/EC, Annex III, Table 2b)[8] (see Appendix 2). Activities in accordance with this definition include e.g. industrial manufacturing, agriculture, transportation on land and at sea, fishing and waste management. Identifying these types of activities is described as important for linking the various implementation steps of the Directive, and has also been incorporated as the Activities (A) node in the DPSIR framework (EC, 2020). In marine environment management at both European and Swedish levels, identification of the activities that contribute most to the pressure on the sea have been given special attention, with the aim of directing measures towards these activities. HELCOM has also carried out such evaluations for the Baltic Sea during 2020 to in the process to update the Baltic Sea Action Plan.[9]

The identification and quantification of activities that contribute directly to pressures on the marine environment can contribute to the analysis of drivers, but in comparison with actor analyses these assessments are limited. As detailed in chapters 3 and 4, actor analyses also include those activities that have an indirect impact on the environment, for example through a production chain, or those authorities that affect other actors through guidance and decisions. An actor analysis thus identifies all relevant groups of actors that may need to be addressed to improve the marine environment.

In the case that an actor analysis takes as its starting point a specific environmental problem, those activities that cause a direct pressure on the environment will inherently be identified as relevant actors (see chapter 3).

If an actor analysis takes as its starting point an activity with a direct impact on the environment, instead of an environmental problem, a large number of additional actors will then also be identified that affect the environment through decisions, economic interests and access to information. This is exemplified with shipping and fishing in chapter 3.

In both cases there is thus a link between activities as defined by the Marine Strategy Framework Directive and actor analyses.

5.5 REFLECTION

The steps included in the methods described in chapter 4 are largely based on the nodes included in the DPSIR framework or its variants. However, as detailed in this report,

8 The list of activities relates to the amendment decided on in 2017 (EU, 2017/845) and included in the consolidated version of the Marine Strategy Framework Directive dated June 2017.
9 Details of ongoing work and background information are available at https://helcom.fi/baltic-sea-action-plan/som/. Reports with results are expected to be published in 2021.

there are different interpretations and applications of the concept of drivers. In the DPSIR framework, drivers are often described as some type of large-scale societal phenomena that can explain changes in pressures on the environment. Changing the direction of large-scale trends can however be a slow process, and by necessity environmental problems therefore need to be addressed and remedied despite influence from large-scale societal trends. We have therefore mainly focused in this report on the importance of knowledge about desirable and undesirable behaviours among actors to develop policy instruments for a given environmental problem. However, it should be emphasised that the adaptations required in order to achieve a long-term change in direction of large-scale societal phenomena that are negative for the marine environment also require changed behaviours, for example in terms of consumption. From a large-scale perspective, behavioural changes may therefore be required throughout society, and not only by those groups of actors that cause a given environmental problem. Drivers in the form of large-scale trends or as factors for desirable and undesirable behaviours thus have a clear connection, and should not be regarded as two different tracks.

6 BEHAVIOURS, DRIVERS AND BARRIERS OF SWEDISH ACTORS OF RELEVANCE TO THE MARINE ENVIRONMENT

Eutrophication, overfishing and chemical pollution are some of the biggest problems in the marine environment in the Baltic Sea and the North Sea (Swedish Agency for Marine and Water Management, 2018b). For these areas, we have looked for studies and reports that link pressures to underlying actors, behaviours and drivers. The intention has been to show examples of studies that have been carried out, and to identify knowledge gaps. We have looked for studies that explicitly address drivers, but have also included studies and projects that deal with society's actors without using the term *drivers*. We have based our work on studies that we or our colleagues know of or have been involved in, and have also had dialogue with experts and authorities. A full mapping process is outside the scope of this project, so the results should be regarded as an indication of how this area is dealt with.

6.1 EUTROPHICATION

Just like Sweden, many other countries also carry out regular national evaluations of pressures from different sources of nutrients (Ejhed et al., 2016; HELCOM, 2018; OSPAR, 2017). The Swedish Institute for the Marine Environment has mapped the societal phenomena behind these pressures by analysing substance flows and commodity chains for products, and by identifying actors, groups of actors and their behaviours (Sundblad et al., 2014, 2015).

In other projects, analyses of a change in behaviours have shown the clear potential to reduce pressures within four societal phenomena: protein intake, phosphorus additives in food, horse keeping and food waste (Vallin et al., 2016). No analysis of drivers for the behaviours actors has been carried out in these reports, but suggestions for ongoing work have been presented with an emphasis on cooperation between the actors involved.

The Swedish Environmental Protection Agency has analysed and promoted the issue of reducing food waste from resource and climate points of view, and has linked these analyses to different behaviours of actors.[10] The opportunities to reduce the pressure from horse breeding centres were also studied and presented in 2020 in a Swedish Government official investigation, 'Stärkt lokalt åtgärdsarbete – att nå målet Ingen Övergödning' ('Stronger local remedial efforts: Achieving the goal of Zero Eutrophication'). The investigation was tasked with analysing drivers behind local remedial efforts, which policy instruments help to strengthen remedial efforts and how these can be financed. However, the investigation did not analyse drivers in depth (SOU, 2020).

The management of small on-site sewage plants for Swedish households is another area

10 http://www.naturvardsverket.se/Miljoarbete-i-samhallet/Miljoarbete-i-Sverige/Uppdelat-efter-omrade/Avfall/Matsvinn/

that has been studied in depth with the ambition of taking action to reduce environmental pressure. Here, it is emphasised that households' behaviours must be understood on the basis of the individual's internal motivation, external incentive structures and any contextual restrictions. Barriers such as existing infrastructure often affect the opportunities to change behaviours (Wallin, 2013). The study highlights a number of factors with different degrees of motivating or steering impact:

- Benefitting through a safe system
- The opportunity to act immediately
- Doing one's duty
- Inspection from the responsible authorities
- Environmental awareness
- How other households act
- A perception of fairness
- Belief that wastewater treatment is effective for the environment
- Self-interest, for example the financial consequences
- Site-specific conditions that may limit alternative courses of action.

In many places, such as in municipalities and water councils around Sweden, work is being carried out to reduce emissions of nitrogen and phosphorus. Two Government commissions[11] focusing on agriculture have the joint name 'Lokalt engagemang för vatten' ('Local commitment for water'), or LEVA.[12] The work involved with LEVA includes mapping the drivers and barriers of actors (Almstrand, 2021).

The drivers for participating in the Swedish water councils have been mapped with the aim of strengthening local commitment and improving cooperation between different actors within water management. The ongoing Interreg project Water Co-Governance[13] reports that the most common motivations for taking part in the work with the water councils are the individual's need for information, public interest and having an influence.[14]

Focus on Nutrients[15] is a long-term Swedish project aimed at farmers in order to reduce climate impact, reduce eutrophication and encourage the safe use of plant protection products. The project is a collaboration between the Swedish Board of Agriculture, the Federation of Swedish Farmers (LRF) and the county administrative boards, and aims to

11 The Swedish Agency for Marine and Water Management together with the Swedish Board of Agriculture, the Federation of Swedish Farmers (LRF), the River Basin District Authorities and the county administrative boards
12 https://www.havochvatten.se/planering-forvaltning-och-samverkan/program-projekt-och-andra-uppdrag/leva---lokalt-engagemang-for-vatten/levas-atgardsomraden.html
13 https://www.havochvatten.se/planering-forvaltning-och-samverkan/internationellt-samarbete-och-konventioner/internationellt-samarbete/watercog---samarbete-for-lokal-vattenforvaltning.html
14 Personal communication with Madeleine Prutzer, University of Gothenburg, 28 September 2020.
15 http://greppa.nu/

offer information and advice to support voluntary measures. The Swedish Board of Agriculture also has other policy instruments aimed at agriculture. Analyses were originally carried out to identify important general drivers and barriers, but advisory work now takes place with individual farms through annual dialogues. There are no policy instruments other than information within the project. However, it is clear that additional behavioural changes can be achieved using other tools. One example is that the demand for mapping the climate impact by farms, offered by Focus on Nutrients, did not grow until the dairy corporation Arla Food began offering dairy farmers more money for milk with documented climate data.[16]

The Swedish Institute for the Marine Environment produced an overview report for the 2017 UN Ocean Conference which highlights society's drivers: 'Mitigating marine eutrophication in the presence of strong societal driving forces' (Grimvall, 2017). In a global context, nitrogen emissions from shipping, large-scale animal production, aquaculture and sludge from wastewater treatment plants are often highlighted as important areas to continue working with. In the UN report, the term *drivers* is used at a more overarching level than otherwise applied in this report.

6.2 CHEMICAL POLLUTION

We looked for actor and driver analyses regarding pharmaceuticals, chlorinated paraffins and per- and polyfluoroalkyl substances (PFAS).

Swedish studies of pharmaceuticals mainly relate to the effectiveness of water treatment plants and levels in discharged water from these plants and in marine ecosystems (e.g. Svahn & Björklund, 2018; Swedish Agency for marine and Water management, 2018a; Undeman, 2020). This data – combined with comparisons with established environmental quality norms for these substances – highlights the need for measures to reduce the impact on marine ecosystems.

We have not found any studies that analyse drivers behind behaviours of actors in a way that corresponds to the abovementioned study of small sewage plants, or the work carried out by Focus on Nutrients.

However, there is a study of the environmental benefit of five upstream measures involving doctors and other actors. These relate to the reintroduction of prescriptions for environmentally hazardous pharmaceuticals, pharmaceutical reviews between doctors and patients, prescribing physical activity, separate treatment of wastewater from hospitals and care facilities, and streamlining public procurement. The study was financed by Swedish Water Development (SVU) together with Formas and the Swedish Environmental Protection Agency (Graae, 2017). The results may offer a basis for mapping what is needed in order to carry out the measures.

Some examples of projects focusing on actors within society can be mentioned here. An evaluation of environmental information about pharmaceuticals as a measure for reducing

16 Personal communication with Stina Olofsson, project manager at Focus on Nutrients, 28 September 2020.

emissions to the environment is included in the Interreg project CW Pharma, which ended in November 2020.[17] Here, the main aim is for unused pharmaceuticals to be returned.

Another example of a focus on actors relates to the risk involved in antibiotic use due to the development of antibiotic resistant microbes. In Sweden, the STRAMA network works to raise awareness of antibiotic resistance by informing health centres, hospital clinics, local emergency units, authorities, politicians and other decision-makers, schools, preschools, the media and others.[18]

Chlorinated paraffins are used to make textiles flameproof, to stabilise products so that they withstand various temperatures, etc. They are also used in products such as electronics, cables, rubber and construction materials. Different types of these paraffins are found in marine fish, birds and mammals, and also in land animals. The spread of chlorinated paraffins is deemed to be extremely worrying, due to their properties combined with their widespread use and the fact that they make up part of the chemical cocktail in the sea. Since there is now global regulation of one type of chlorinated paraffins, the use of other types is expected to increase. We have not found any studies that analyse the link between an individual field of application and a disruptive impact or analyses of drivers and barriers to avoid the substance.

PFAS have been used frequently and have been detected in Sweden in many different products.[19] Generally speaking, it is in studies of upstream measures that drivers and barriers for behaviours of actors are identified. One Swedish knowledge summary on sampling, incidence, effects and upstream measures includes PFAS in addition to other substances. The study briefly discusses measures aimed at PFAS, including proposals to give consumers more information about products containing PFAS to enable them to make informed choices. However, these proposals were not preceded by any analyses of the drivers for actors to use these products or their opportunities to choose other products (Jönsson et al., 2020).

6.3 OVERFISHING

Overfishing has attracted significant attention within both politics and research. The studies that have been carried out deal with fish, fishing, fish stocks and ecosystems, as well as the problems relating to the use of shared resources, otherwise known as ‘the social dilemma’. In certain studies, the depletion of fish stocks has been attributed to factors such as climate change and overfishing (Moksnes, 2011), and to fundamental imbalances in ecosystems (Svedäng et al., 2018). Other studies argue for specific causes such as food shortages (Eero et al., 2012; Kulatska et al., 2019), the effects of bottom trawling (Wikström et al., 2018) and deoxygenated seabeds (Casini et al., 2016). Studies and data to support decision-making are available via ICES for many species and basins –

17 https://www.cwpharma.fi/en-US
18 https://strama.se/
19 Non-stick cookware, car wax and upholstery, tablecloths, firefighting foam, printer ink, floor polish, impregnation of glass and plastics, insecticides, cardboard, cosmetics, carpets, umbrellas, pizza boxes, popcorn paper, ski wax, smartphones (dirt-repellent surface treatment), lubricants, dishwasher rinse aid, tents, suitcases, dental floss, photographic materials, leisurewear.

both at EU level and nationally.

Within behavioural science, there are also studies which assess different types of management tools for dealing with a shared resource such as fishing, as well as factors that can support sustainable fishing. However, fishing is largely regulated, which is why many actors have little opportunity to act freely.

Today's management lacks the tools to resolve the problems that exist, and this needs to be rectified. A new description of fishery management (Swedish Agency for marine and Water management, 2020) includes barriers and opportunities in the form of different actors' areas of control.

6.4 CONCLUDING REFLECTIONS

This chapter shows that systematic reviews of the flows, systems and decisions that precede the pressures on the marine environment, together with actor analyses, can contribute valuable data for remedial work and decision on measures. The analyses carried out in Sweden show that important local measures are possible from many actors to whom only limited attention has been paid to date. In terms of the eutrophication problem, for example, there are actors linked to small sewage plants and horse keeping. When it comes to overfishing, analyses have shown that the Swedish fish consumer does not have significant opportunities to influence fishing as a whole – instead, other actors play a decisive role.

More studies are needed which highlight actors and groups of actors, in addition to the analyses based on more large-scale concepts. Consumption is one such overall concept that is mentioned as a driver of environmental problems (see also chapter 5.2 and EEA, 2019). In 2018, the PRINCE research project drew up national indicators for environmental impact from Swedish consumption (Steinbach et al., 2018). National indicators make it possible to monitor the scope and provide data for the administering authorities. The Swedish Consumer Agency and Mistra Sustainable Consumption have a joint programme that identifies and supports studies to provide better data for measures, policy instruments and initiative, with a focus on climate-related measures.[22] There are currently no corresponding programmes or commitment for marine environment impact.

Many studies that take a pressure as their starting point limit themselves to identifying the sectors or activities involved. It is thus the sector – or the party that will consider changes – that needs to deepen analyses and draw up additional materials. Since many pressures on the marine environment are caused by many different processes within society, with actors who are dependent on each other, comprehensive actor analyses would be extensive in nature. We have not identified any examples affecting Swedish seas where analyses have been used in a systematic manner. Since systematic actor and driver analyses have not been carried out in Sweden to any significant extent, the competences and resources needed to carry out effective mapping have also not been identified.

7 CONCLUSIONS

In this report, we have reviewed the concept of drivers and how they can be considered within marine management work to develop policy instruments and measures for a better marine environment. Our conclusions are summarised below under five points.

Marine management takes place in the presence of drivers at different levels of society
The marine environment and its management can be affected by drivers at global, regional, national and local levels. It is also evident that drivers on different scales can counteract or reinforce each other. Large-scale societal phenomena such as technological advances, population growth, urbanisation, international trade and general trends in private consumption affect pressures on the sea, and thus constantly create changed conditions for marine management at lower administrative levels. Conversely, drivers and actors at local level can affect how marine environment issues are dealt with at higher levels within society.

In the DPSIR framework and its successor DAPSI(W)R(M), the letter D primarily stands for large-scale Drivers that affect entire sectors of society. This report points out that the documentation for developing measures at national and regional levels needs to be extended and made more specific, so that it highlights actors and their drivers and behaviours at several different levels within society.

Analyses of actors and their behaviours have a natural link to the term 'activities' in the Marine Strategy Framework Directive
In the implementation of the EU's Marine Strategy Framework Directive, the term *activities* is used to describe areas or sectors in society that contributes to a direct pressure on the sea. The term *actors* is more specific than *activities*, in that an activity can be linked to many different actors. The terms *actor* can also help to identify additional individuals and organisations that indirectly contributes to pressures on the marine environment in various ways. We therefore do not see any barriers to linking analyses of actors and their behaviours to the mapping of activities and their impact on the marine environment according to the Marine Strategy Framework Directive. On the contrary, actor analyses can contribute to meet the Directive's requirements for developing action programmes.

There are established methods for carrying out individual steps in an overall analysis of drivers, actors and behaviours, but there is a lack of studies that go all the way from drivers to measures and policy instruments
Our review of scientific publications and reports on societal phenomena that can affect the marine environment shows that there are only a few studies in Sweden linking pressures on the sea with actors within society and their drivers and behaviours. There is also a lack of such studies for the marine environment at international level.

Actor analyses are an established tool within both research and management. There are also well-founded scientific theories about which factors control the behaviours of individuals and organisations. Despite this, there is a lack of good examples of the practical implementation of studies linking the identification of drivers and actors with assessments of the conditions required for changed behaviours and development of policy instruments.

Since analyses of actors and drivers are context-bound, this should ideally be done in coherent studies. One explanation for the lack of such studies may be that they require fairly extensive data collection and an interdisciplinary way of working.

The choice of detail level and context is important for advances in remedial work

In order to be able to remedy marine environment problems, it is appropriate to 'zoom in' on individual actors as well as to 'zoom out' and look at larger parts of entire systems within society. The solutions to problems may be found at different levels.

Every situation where an administrator considers introducing regulation should be dealt with individually and as part of the system to which it belongs. Analyses that intend to provide support for marine management therefore typically focus on a particular substance group (such as dioxins), or a particular behaviour (such as illegal fishing). Geographical delimitation (such as the Kattegatt) may sometimes also be necessary.

If the field is too broad, such as 'environmental toxins in the marine environment' or 'overfishing', an actor analysis will quickly become so extensive that it is hard to manage. An analysis of drivers also risks ending up at such an abstract level (population growth, consumption, etc.) that it is not useful for devising policy instruments. On the other hand, it is not always necessary to go into depth with every group of actors within an entire system. By reviewing the entire chain in a system, certain sections may be seen to be more important to begin with.

Analyses of drivers and actors reinforce management across sectoral borders

Much of society carries out activities that have an impact on the marine environment. Hence, marine environment management needs to cover cooperation with and between sectors and sector authorities to a greater degree, and different authorities need a clear mandate to act. The analyses of drivers can facilitate the identification of situations when goals of the marine environment are in conflict with other societal goals. They can probably also contribute to cooperation between actors with different motives to identify broad solutions by mapping conditions and barriers for changed behaviour.

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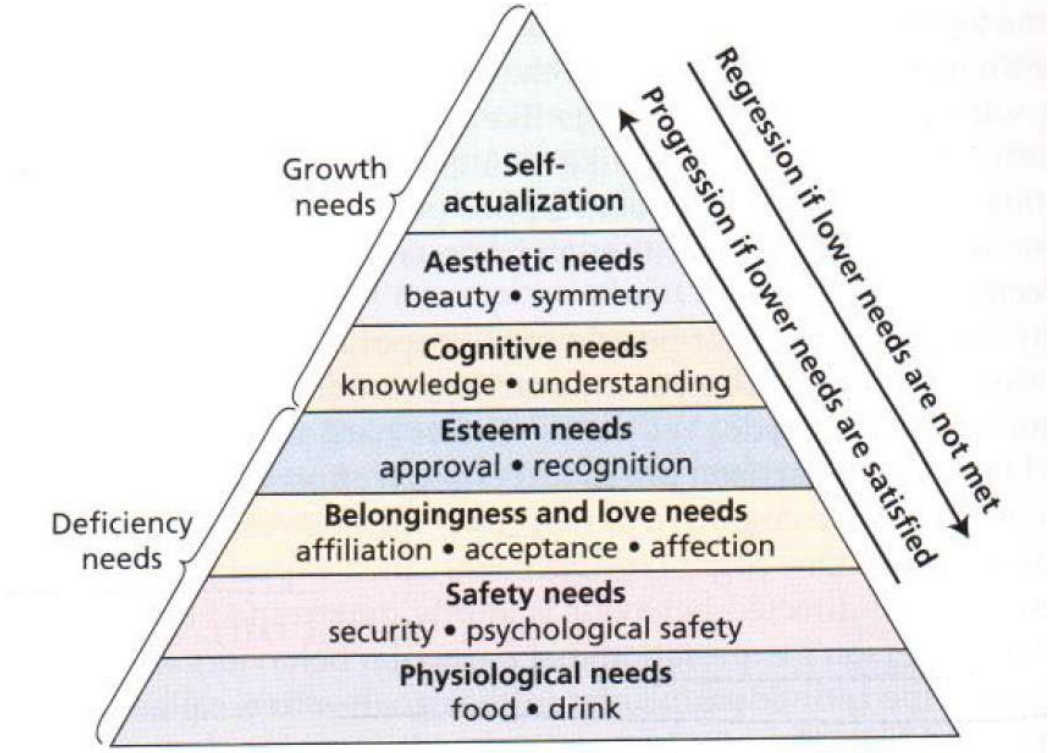
APPENDIX 1

Maslow's hierarchy of needs. Maslow proposed that needs are arranged within a hierarchy. Once more basic needs have been met, we need progression and focus on needs at the next level. If a need at a lower level is no longer satisfied, we experience a needs regression and focus again on meeting the needs at a lower level.



APPENDIX 2

Activities in accordance with the guidance contained in EU Directive 2017/845, for the framework directive on a marine strategy (2008/56/EC, consolidated version), Annex III, Table 2b.

USES AND HUMAN ACTIVITIES IN OR AFFECTING THE MARINE ENVIRONMENT WITH PARTICULAR RELEVANCE TO ARTICLE 8 8.1 B AND C. (ONLY ACTIVITIES MARKED WITH * ARE RELEVANT TO ARTICLES 8.1 C, 10 AND 13.)	
Theme	**Activities**
Physical restructuring of rivers, coastline and seabed (water management)	Land claim
	Canalisation and other watercourse modifications
	Coastal defence and flood protection*
	Offshore structures (other than for oil/gas/renewables)*
	Restructuring of seabed morphology, including dredging and
Extraction of non-living resources	Extraction of minerals (rock, metal ores, gravel, sand, shell)*
	Extraction of oil and gas, including infrastructure*
	Extraction of salt*
	Extraction of water*
Production of energy	Renewable energy generation (wind, wave and tidal power),
	Non-renewable energy generation
	Transmission of electricity and communications (cables)*
Extraction of living resources	Fish and shellfish harvesting (professional, recreational)*
	Fish and shellfish processing*
	Marine plant harvesting*
	Hunting and collecting for other purposes*
Cultivation of living resources	Aquaculture – marine, including infrastructure*
	Aquaculture – freshwater
	Agriculture
	Forestry
Transport	Transport infrastructure*
	Transport – shipping*
	Transport – air
	Transport – land
All urban and industrial uses	Urban uses
	Industrial uses
	Waste treatment and disposal*
Tourism and leisure	Tourism and leisure infrastructure*
	Tourism and leisure activities*
Security/defence	Military operations (subject to Article 2(2))
Education and research	Research, survey and educational activities*

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the Marine Environment