UiT The Arctic University of Norway

Faculty of Biosciences, Fisheries and Economics - Norwegian College of Fishery Science

A visitor that has come to stay? The case of pink salmon (Oncorhynchus gorbuscha) in Norway

-

Andrea Sofie Hansen Aspelund

Master thesis in International Fisheries Management (30 ECTS) …. FSK-3910 …. May 2020

Summary

This thesis is dedicated to the case of the pink salmon (Oncorhynchus gorbuscha) in Norway. The pink salmon has a large native range and is indigenous to regions of the Pacific Ocean. It was deliberately introduced into rivers that drained into the White Sea by the Soviet Union. This was done through several attempts reaching from 1957 to 2001. These attempts resulted in secondary expansion to the Northern Atlantic and the Barents Sea. The pink salmon demonstrated a high ability to disperse but did not show signs of establishment. Low amount of pink salmon has been observed in the following decades after the attempts of introduction. This remained the case until a sudden and rapid change in 2017. In 2017, pink salmon were observed and caught in over 200 rivers in Norway. Several other countries in northern Europe also experienced an increase in the abundance of spawning pink salmon, but Norway had the highest increase. The pink salmon has distinct groups of odd year- and even year broodlines. The odd year broodline appears to be the strongest, which is further supported by the high amount of pink salmon in 2019. Alien species are considered as the second biggest threat to biological diversity by the Norwegian government (regjeringen.no). Alien species are to be managed in accordance with national legislation and international agreements. The thesis aim is to ascertain whether the pink salmon has come to Norway to stay based on the properties of the management system and the unique biological characteristics of the pink salmon. Challenges are identified and assessed by acquiring an overview of the management system and the pink salmon itself. This thesis has a multidisciplinary approach, because there are several aspects of the case that can determine the outcome.

Keywords: Alien species, Alien invasive species, Norwegian management system, risk management, implementation theory, conservation biology

Table of Contents

List of Tables

List of Figures

1. Introduction

An alien species or organism is defined by the Norwegian government as an organism that does not occur naturally in any place within the Norwegian boundaries. It considered one of the biggest threats to biodiversity as there might be a lack of natural predators in the new environment. This may lead to displacement of native fauna and flora [1]. There have been several cases of alien species being introduced at another location, which resulted in secondary spread into Norwegian ecosystems, for example, the Pacific oyster (Crassostrea gigas), the Arctic red king crab (Paralithodes camtschaticus) and the pink salmon (Oncorhynchus gorbuscha). The pink salmon will be the case of this thesis, but there are parallels to the other cases that can provide indications to the future management of the pink salmon. All the examples are a result of secondary expansion after deliberate introduction into another ecosystem. The introductions were motivated by prospects of increased food supply and potential economic gain.

The Norwegian government have taken measures through management plans in cases of the Pacific Oyster[2] and the Arctic red king crab [3]. Such a measure has not so far been taken regarding the pink salmon. There can be several reasons for this as the pink salmon is more recent in increase of abundance and there is a lack of knowledge. Both the Pacific oyster and the Arctic red king crab showed signs of establishment before the pink salmon. The Pacific oyster and the Arctic red king crab have been assessed with a higher ecological risk, but all three species have the same degree of risk for further expansion. One of similarities in the management plans for Pacific oyster and Arctic red king crab is that there is not any eradication effort, but rather a focus on limiting further expansion.

UNCLOS[4] article 196 (1) asserts that "*States shall take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of technologies under their jurisdiction or control, or the intentional or accidental introduction of species, alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto.*". Controlling alien- and new species if introduction has occurred is

[1] Regjeringen.no (2014, 13.10). Link: https://www.regjeringen.no/no/tema/klima-og-miljo/naturmangfold/innsiktsartikler-naturmangfold/fremmede_arter/id2076763/
[2] The Norwegian action plan against Pacific oyster (2016): https://tema.miljodirektoratet.no/Documents/publikasjoner/M588/M588.pdf
[3] Management of the Red King Crab (2007) - white paper : https://www.regjeringen.no/contentassets/3a82509cc5694fa395654e4b01f3a0c5/no/pdfs/stm200620070040000dddpdfs.pdf
[4] United Nations Convention on the Law of the Sea (1982)

often the most reasonable strategy as eradication measures is either too costly or futile. In the case of the pacific oyster eradication measures is not applied. This is due to a lack of knowledge about effective measures to develop a combat strategy (Miljødirektoratet, 2016: 8).

Legal issues in combination with economic gains are other factors that can complicate eradication measures. Eradication efforts in cases where there is a secondary expansion can also be futile without international/bilateral cooperation for alien species that exist across national borders, and if it is a valuable species there may not be a government incentive to eradicate. The Arctic red king crab is an example of a valuable species and its presence in the north-east Atlantic is profitable for both Norway and Russia. Norway currently has a national management regime with one quota regulated fishery in the east- and another open-access area in the west. One of the objectives in this management regime is to limit further expansion by the Arctic red king crab with an aim of also maintaining a viable, long term fishery (Sundet & Hoel, 2016: 281).

Textbox 1. Definitions of terms:

Alien species (**non-native, non-indigenous, foreign, exotic) -** means a species, subspecies, or lower taxon occurring outside of its natural range (past or present) and dispersal potential (i.e. outside the range it occupies naturally or could not occupy without direct or indirect introduction or care by humans) and includes any part, gametes or propagule of such species that might survive and subsequently reproduce.. (IUCN, 2000:5)

Alien invasive species - means an alien species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity. (IUCN,2000:5)

Introduced - means the movement, by human agency, of a species, subspecies, or lower taxon (including any part, gametes or propagule that might survive and subsequently reproduce) outside its natural range (past or present). This movement can be either within a country or between countries (IUCN, 2000:5). This could be either intentional- or unintentional introduction.

1.1 Problem statement:

Alien species[5] are considered the second biggest threat to biological diversity after habitat loss (regjeringen.no, 2019). This view on alien species is evident in international agreements and

[5] This thesis will further continue to use alien species as a common term for all species that has been assisted by humans over a natural barrier and can become established or invasive. Alien invasive species will be applied when a species has been classified as such by establishing and is an agent of change, and thus becomes a threat. Alien invasive species will also be applied when it is considered necessary to be specific in terms of increased ecological risks. Terms will not be altered when used in legislation or agreements.

consequently in national legislation in Norway. Reaching the overarching goal of conservation of existing ecosystem takes considerable amount of resources and creates challenges not easily resolved, especially considering that nature is always changing. In cases of secondary expansion of alien invasive species there are additional challenges in managing these resources like jurisdictional issues. The biology of the species also differs which makes each case unique and creates different challenges associated with each alien species.

The objective of this thesis is to identify and assess the management of the pink salmon in Norway. In order to do this there is a need to give an overview of the management agencies, legislation and management measures. This can contribute towards addressing whether the management system is adequate to handle this and possibly other cases of alien or alien invasive species. The case of the pink salmon will be assessed based on its own unique impact on social, biological and economical dimensions of sustainability. A warmer climate can lead to a faster expansion and colonization by foreign species, so it can be expected that the issue of alien invasive species will increase in the future (Hilmo, 2015). Climate change is an example of a present and future challenge that management agencies need to account for when allocating resources and developing strategies against alien species.

The legal framework is the foundation for creating a strategy for management of alien species. Therefore, it is of high relevance to consider the international commitments, scope of the law and chain of actions taken on the basis of these.

1.2 Research questions:

The research questions will identify challenges that an invasive foreign species such as the pink salmon causes the Norwegian management agencies. The research questions are as followed:

- The entry of the Pink Salmon into Norwegian rivers – is it a problem that needs or can be solved?
- What measures are applied by the Norwegian government to address the issues caused by alien species?
- Is the Norwegian management system adequate through the current legislation to handle the case of the pink salmon?

The current indication of establishment by the pink salmon and sudden increase makes it a more pressing issue for Norwegian management due to the requirements of international agreements, Norwegian legislation and the attitudes and responses of civil society. It is

therefore currently getting a lot of attention from the public as well as scientists and management agencies. How Norwegian management approaches the pink salmon will show the strengths and limitation in the legal framework and its implementation surrounding alien species in this specific case. As the Norwegian management system has an objective of protecting the biodiversity in ecosystems against threats from alien species, this case study can give insight into if Norwegian management agencies can accomplish this based on the current legal framework. The increase in abundance of a species that previously wasn't self-producing can be an indication of changes in the Norwegian waters, and this thesis can give insights into how prepared the Norwegian management system is for future changes which may affect the biodiversity of the Norwegian coast.

1.3 Theoretical framework

The thesis requires theoretical perspectives from different disciplines. A multidisciplinary approach offers more viewpoints to base the conclusion upon. Whether the pink salmon is or is not in Norway to stay is dependent on many factors, so by not narrowing it down to one discipline more aspects of the case can be explored. There are three theories in the thesis and was chosen based on the scope. These theories are conservation biology and opponent views, implementation theory and risk management theories.

1.3.1 Conservation biology and the sceptics

There are different theories about the impact that alien species can harbour on ecosystem. On one side there is the invasion biologists within the field of conservation biology. Sagoff has divided areas of invasion biology into four areas: 1. cost estimates of the effects of nonindigenous species, 2. invasive species as significant extinction threats, 3. alteration of the normal function of the ecosystem, communities and processes, and 4. Ontological dualism, which distinguishes the natural and anthropogenic processes and influences (2019:1-2). There is a distinct science community within the field of invasion biologists where a consensus resides behind these four areas (Sagoff, 2019:1).The goal of invasion biology can be summarized as:

> "Preventing harm to humans and their economic interests (e.g. infrastructure, agriculture, etc.), conserving native and endemic species, ecosystems, and biodiversity, and preventing biological invasions from homogenizing ecosystems across areas, even if invasions may in some cases increase local or regional species richness". (Frank, 2019:6)

The cost of damage control caused by alien species adds up to a large amount for States. Often cited cost estimates in relation to this is the work of Pimentel et al. Pimentel et al. uses the U.S as an example how the changes caused by alien species is not beneficial from an

economic and ecological perspective[6]. Changes in aquatic ecosystems are alterations that causes an increase extinction rates of native species (Pimentel, Zuniga, & Morrison, 2005:278). According to Pimentel et al. estimations there are benefits derived from exotic species but this is nothing compared to the cost of the negative impacts (Pimentel et al., 2005:278)[7]. Although most alien species are not able to establish in a new environment the estimation of cost of the one's that do is high. Ecological factors that may be present for the alien species to become established and invasive are for example the lack of effective predators or high adaptability (Pimentel et al., 2005:282). Focus on prevention measure is advised by Pimentel et.al (2005).

The second area of invasion biology is about alien species as the "second greatest threat" after habitat destruction to native fauna and flora (Sagoff, 2019:8). According to invasion biologist this also include non-predatory species (Sagoff, 2019:2). This conviction is shared by many within the field of invasion biology.

The third area is about the biological differences between native and non-native. These differences in biological characteristics might disrupt and damage the structure and function of ecosystems after an invasion (Sagoff, 2019:10). The invaders will have certain biological characteristic which might disrupt the structure and function of the ecosystem, while the natives have more suitable characteristics as they are an integrated part of an ecosystem.

Ontological dualism refers to the criteria of history of arrival that need to be present to deem a species as alien. An 'introduced population' arrives either intentionally or accidentally by human assistance (Sagoff, 2019:12). While an 'invasive population' is a "introduced population that spreads and maintains itself without itself without human assistance" (Sagoff, 2019:12). It is the causation of human involvement at some point that deems a species as an alien (Sagoff, 2019:12). Sagoff defines the ontological terms of invasion biology as " invasion biology must divide human beings – or some of them – from the rest of nature as separate kinds of agents" (Sagoff, 2019:13)

On the other hand, there are those that are sceptic of invasion biology, and offer an alternate view on alien species. These sceptics are often deemed as 'invasion species denialist'(Sagoff,

[6] Pimentel et al. uses examples of a variance of introduced organisms. Examples includes both terrestrial-, aquatic-and microorganisms

[7] These estimations were published in 2005 and therefor it can be expected that there have been significant changes. Due to the most likely changes the numbers of the estimates is irrelevant, but this merely serve the purpose of illustrating the view that the cost outweighs the benefits.

2019:2). 'Denialists' are accused of criticizing " the influence of values on the application and interpretation of invasions science, but that "scientific facts are not disputed"" (Sagoff, 2019:2) Some of the criticism against invasion species biology" resides in the estimations of cost provided by Pimentel et al. is not "backed by empirical evidence"(Sagoff, 2019:2). Some are also of the view that alien species is not as problematic as indicated by international- and national legislation. The terms alien- or foreign species can automatically make them a threat while that may not be the case, but this can rather be a result from human's fear of the unknown[8]. Pearce offers a point of view that differs from traditional ecology theories. Pearce argues that the abilities of alien species to colonize is rather an expression of nature's resilience (2015:2). Pearce acknowledges that there exist horror stories of alien species, but that most alien species either swiftly die out or become a contributing part of the ecosystem (Pearce, 2015:2-3). Pearce suggest the term 'new natives' as an alternative rather than 'aliens'(Pearce, 2015:2). This is reasoned in that nature is always changing and never goes backwards. Researchers like Chew et.al, also argues that there is wasted too much effort in differentiating between 'alien'- and native species, and that categories like 'native' does not hold up under scrutiny and is codified in terms of how humans view belonging (2011:36). So according to these arguments' terms like alien- or non-native species does not perhaps express how nature work, and the terminology currently used in international agreements may not be suitable.

1.3.2 Implementation theory

There's a lack of grand theories within implementation as generalizations has been proven hard to accomplish. Implementation theory has been through stages of development. In a dissertation by Gunnar Sander called *Implementation of ecosystem-based ocean management*, there is given a description of the three stages of development before implementation studies appear to have seemingly faded out (2018:36). The first phase were explorative and descriptive single-case studies (Sander, 2018:36. The second phase "attempts for theory development and guidance for research results in confrontations between top-down and bottom-up perspectives"(Sander, 2018:36). The third phase moved in a more quantitative direction to synthesize a general theory of implementation (Sander, 2018:36). Some of the suggestions towards improving implementation research is by "accepting theoretical diversity" and "create and test partial theories and hypothesises rather than trying to reach for utopia in constructing a general implementation theory" (Winter, 2012:265).

[8] As put by Fred Pearce "native is good, and alien is bad" (2015:1)

In addition to the lack of grand implementation theory there is little research done in relation to implementation in ocean management. In his dissertation, Sander applied a general framework of for studies of implementation created by Winter (Sander, 2018:36). In the framework by Winter results can be measured by outputs or outcomes. Winter advises to "focus on outputs (behaviours of implementers) and outcomes as dependent variables rather than goal achievements" (Winter, 2012:265). Output refers to regulations and services implemented. Outcomes refers to the impact of policy either to the extent to which the goals of a plan have been achieved or problems that have motivated the implementation of the policies has been solved (Sander, 2018:36-37).

In the framework provided by Winter there is inclusion of street level-bureaucrats within the implementation process. This can be considered as an "attempt to build a bridge between striding factions of top-down and bottom-up analyst" (Sander, 2018:37).

Challenges of implementation within ocean management is apparent when looking at the countries application issues of ocean management approaches like for example Ecosystem-Based Management (EBM) and Ecosystem Approach to Fisheries (EAF). The progress of implementation of these approaches is slow, even though countries receives support and guidance from UN and other international organizations (Sander, 2018:32). This is evident by the fact "that most countries did not meet their commitment to implement the approach[9] for all their fisheries by 2010" (Sander, 2018:32). Implementation of these approaches can be especially challenging as it is full of paradoxes and tensions between conflicting interests (Sander, 2018:33). Some of these paradoxes and tensions can be related to decision-making, addressing conflicts, scale and sustainability between economic and environmental gains (Sander, 2018:33).

1.3.3 Risk management

Theories on risk management regarding fisheries is not a wide field. In the work that has been retrieved methods of risk management is described as "Risk management methods provide means to address increasing complexity for successful fisheries management by systematically identifying and coping with risk"(Sethi, 2010:341). The complexity increases the challenges facing successful management, and the recommendation from scientists within the field of fisheries is for management to include risk and uncertainty into the decision-making process (Sethi, 2010). The methods of risk management can derive from several

[9] Ecosystem Approach to Fisheries (EAF)

disciplines as fisheries has a biological, social and economic dimension. Risk in itself can be defined as " a risk entails the ideas of variability, uncertainty and loss, leading to the following definition: a chance of adverse effects from deviations from expectations"(Sethi, 2010:343). The precautionary approach is an example where uncertainties and risk are to be taken into consideration under the decision-making process. "Risk management is a loose term for the general process of identifying, characterizing and reacting to risk" (Sethi, 2010:343). Other more precise definition of risk management can also be applied like "the identification, measurement, control and financing of risks which threaten the existence, the assets, the earnings or the personnel of an organization, or the services it provides"(Sethi, 2010:343). It has a pragmatic goal of minimizing the effects of unpredictable variability (Sethi, 2010:343).

Risk management can be compromised by two stages; the first stage is *identifying* and *characterizing* risks, and the second stage is *treatment* (Sethi, 2010:343). The first phase is often referred to as risk assessment (Sethi, 2010:343). The treatment can be summarized into three action for dealing with risk, which is avoiding, transferring or retaining risk (Sethi, 2010:343). Another alternative is to do nothing.

1.4 Method

The thesis provides an overview of the management system of alien species in Norway and is primary concerned with the case of the pink salmon. The reason I choose to have a single-case perspective is because each species is unique in its ecological impacts and invasion rate, due to a range of different factors. So, by to examining it in a single-case perspective I gained more in-depth knowledge to base my analysis on. The case of the pink salmon was chosen due to its relevance as having recent signs of establishment and higher abundance than previously observed.

The thesis contains chapters pertaining to the biological characteristics of the pink salmon, and the legal framework and measures that are applied. I discovered when starting the thesis that it was necessary to involve different aspects of the case to get an in-depth understanding of the challenges that pertains to the pink salmon from a management perspective, therefor this thesis is multidisciplinary. When studying challenges of management agencies, it is natural to include the rules, regulations and laws from which they operate. I also saw the importance of including the roles that each actor has within the Norwegian management system surrounding alien species. Roles of management agencies are essential when it comes to implementation of measures.

In order to answer the question if the pink salmon is in Norway to stay, then part of the answer can be found in the ability to implement suitable measures and another part of that answer can be found in the risk assessments. The thesis is analysed by first providing a holistic view by including the different components of the management system. Challenges are then identified by searching for themes in the literature that is shedding light on the case. Based on selected theories and supporting evidence, conclusions on the research questions will be drawn.

1.4.1 Case study

Since this thesis concern itself with the challenges related to the policy aspect of an alien species, I choose to have a qualitative approach by doing a case study. I gathered qualitative data with the purpose of understanding a phenomenon. A case study can be defined as "a form of qualitative research that is focused on providing a detailed account of one or more cases" (Johnson & Christensen, 2019:580). Further, a case can be defined as a bounded system (Johnson & Christensen, 2019:580). A bounded system consists of different components, and the researchers if often interested in how this system operates with a holistic view (Johnson & Christensen, 2019:581). An important part of conducting a case study is to identify the outline of the bounded system. The design can include several methods based on the information that the gathered data provides (Thagaard, 2013:55).

I constructed the research questions with the intent of providing guidelines and narrow in the scope of the thesis, without being too rigid. As stated by Thagaard, the research questions should function as guidelines for the method- and professional choices that the researcher must make during the project (2013: 51). The research question should also narrow the scope but still be flexible enough to explore other interesting themes that may arise (Thagaard, 2013: 51). During this project, I further developed the research questions along with the progression of the thesis.

1.4.2 Document study

The study of documents is a well-established tradition within qualitative research. A document study can be defined using data that has been written with different intentions or purpose than for that of the researchers (Thagaard, 2013:60). The data is documents within a specific theme where some are central and others peripheral. Central documents pertaining to the specific theme of the thesis pertains to pink salmon in Norway, government documents and legislation that includes alien species and/or ecosystem reasoned in that legislation is rarely species-specific.

1.4.3 Data collection

This thesis has a qualitative approach with emphasis on literature research. The literature consists of primary and secondary sources. Primary sources are legislation, international agreements and documents published by governmental institutions. These sources give insight into the general principles, policy goals, rules, guidelines and chain of action that the management system surrounding foreign species relies upon. The primary sources were collected through a legislative information system[10], governmental sites[11] and established sites for the international agreements[12]. I considered these as reliable sources for collection of data because these are serious actors that provide authentic information. In instances where Norwegian legislation needed to be translated, I choose to include the non-translated text in underlaying footnotes in order to provide access to the authentic text.[13] The criteria for the selection of relevant legislation were legislation that included alien and/or alien invasive species since legislation is rarely species-specific.

The criteria for the selection of the cases presented in the thesis were not selected based on being of similar species, but rather of the means of arrival. I reasoned that the means of arrival was more significant due to being results from introduction with a secondary expansion to Norway, and thus having similar circumstances. Means of arrival also offers more coverage than biological traits. The selected cases are results of introduction with a secondary expansion to Norway[14]. Two other cases apart from the case of the pink salmon has been mentioned in this thesis. The two other cases are used as examples based on similarities of the cases. The selected cases provided some insight into the issues or limitation that has appeared. The cases are that of the Arctic red king crab and Pacific oyster. Primary data was used in relation to these cases consisting of management action plans for the Arctic red king crab[15] and the Pacific oyster[16]. I also choose to use a selected article[17] published in a scientific

[10] Lovdata.no
[11] Regjeringen.no, Miljødirektoratet.no, Kyst- og fiskeridepartementet, NASCO.int
[12] Un.org, Cbt.int, Cms.int
[13] Translated legislation has also been collected when available from the site lovdata.no
[14] They have also established and been classified as invasive species
[15] Management of the Red King Crab (2007) - white paper : https://www.regjeringen.no/contentassets/3a82509cc5694fa395654e4b01f3a0c5/no/pdfs/stm200620070040000dddpdfs.pdf
[16] The Norwegian action plan against Pacific oyster (2016): https://tema.miljodirektoratet.no/Documents/publikasjoner/M588/M588.pdf
[17] J. H., & Hoel, A. H. (2016). The Norwegian management of an introduced species: the Arctic red king crab fishery. Marine Policy, 72, 278-284.

journal to get a further understanding of the issues that has presented themselves in the case of the Arctic red king crab.

I also used secondary sources as scientific articles, books and reports. These furthers the understanding of the challenges related to management of either alien organisms or specifically to the case of the pink salmon in Norway. These sources were gathered by using selected keywords to find relevant articles in the university library databases and through Google Scholar. These articles also provided other sources through their own references. The book *The New Wild* by Fred Pearce were gathered from a source reference list. The reports are risk assessments created by reliable scientific institution and committees. The risk assessments of the pink salmon were created by the Norwegian Biodiversity Information Centre – NBIC[18](2018) and Norwegian scientific committee of food and environment[19](2020). These risks assessments give valuable information about the ecological, social and economic impacts (or potential impacts) of pink salmon in Norway. A report from a symposium held by NASCO has also been gathered, as it was about recommendation on future management challenges for the wild Atlantic salmon and where they addressed the issues of alien species[20].

1.4.4 Limitations

I narrowed the scope to assessing and identifying the challenges pertaining to managing the pink salmon. The circumstances surrounding one case gives in-depth knowledge to apply in the analysis. The drawback is that it is might not be applicable or illustrate the challenges pertaining to other cases of alien species as circumstances vary. There can also be made a case that other factors than the ability to implement suitable measures, the biology of the pink salmon or the legal framework can contribute towards answering whether this is specie will be a problem that refuses to let go. I choose to focus on the biology as it is the direct cause of impact and from which it is assessed. The roles of management agencies, implementation of

[18] The Norwegian Biodiversity Information Centre – NBIC (Artsdatabanken) https://artsdatabanken.no/fremmedarter/2018/N/29

[19] Vitenskapskomiteen for mat og miljø (VKM) - https://vkm.no/risikovurderinger/allevurderinger/risikovurderingavpukkellaks.4.303041af169501216097605d.html

[20] NASCO (2019), CNL(19)16 , *Report from the Tromsø Symposium on the Recommendations to Address Future Management Challenges*. Link: http://www.nasco.int/pdf/2019%20papers/CNL(19)16_Report%20from%20the%20Troms%C3%B8%20Symposium%20on%20the%20Recommendations%20to%20Address%20Future%20Management%20Challenges%20.pdf

measures and legislation part of the thesis will provide weaknesses and strength with those that assess and manage the pink salmon.

There is also a lack of knowledge as this is a quite recent case. I decided during the preliminary research for this thesis that there was sufficient amount of data for a document study. This is reasoned in that there already exist a legal framework and policies that the management agencies comply with regarding cases such as the pink salmon. There is also two risk assessment on pink salmon available. It could also have been advantageous to include interviews with the management agencies, the NBIC or the Norwegian committee for Food and Environment but the lack of time prevented this addition. This could have provided some insight into how the issue of pink salmon is perceived by the those who manage it and from those that assesses the risks associated with the pink salmon.

The use of similar cases can give indication into future development of the pink salmon, but this should be considered with caution since these are species with different biology, which results in different capabilities of impact. The difference in biology can also mean that there is some difference in legislation that regulates the species. These differences can lead to application of different measures to control, contain or eradicate the species.

1.5 Structure

The thesis consists of six chapters. Chapter one gives a thorough introduction to the thesis. It provides the general outline, scope, methodology and theoretical framework of the thesis. Chapter two gives a detailed description of the biology of the pink salmon. This chapter offers insight into the species itself and impacts that can arise due to its biology. It provides information on the pink salmon's biological traits, potential impacts and history of arrival in Norway. It also includes a general overview of the pink salmon in its natural distribution-range, and within Norway. Chapter three describes the legal framework. This is providing information of what is done based on agreements, legislation and roles of management to address the challenge. Chapter four examines the different management measures that is applied, which would be how the management agencies operates. Chapter five contain the discussion and conclusions.

2 The biology of the pink salmon (Oncorhynchus gorbuscha)

The biology of the pink salmon is a direct cause of impacts that results in a unique imprint on ecosystems. So, it is important to understand its biological traits as it can be a cause of damage or benefit for the environment. The chapter gives an overview of traits, native- and non-native range of distribution, history of arrival and capacity for expansion in Norway. Lastly, potential impacts of the pink salmon in Norway will be covered.

2.1 General overview of distribution

The pink salmon (Oncorhynchus gorbuscha) belongs to the salmonid family. It's in size the smallest but with the highest abundance among the pacific salmons[21]. Its native range is quite large but the most abundant population are found in the northern regions of the Pacific, both on the north-American side (from Alaska to Puget Sound(48°N)) and from Siberia to southern Sakhalin (40°N)) (Sandlund et al., 2019: 1034). It exists as well in the northern Atlantic, but this is not due to natural migration but is a result of deliberate introduction. The Pacific and the northern Atlantic have different conditions, and the pink salmon didn't seem in the beginning as becoming self-producing or established in this new environment. It's presently distributed in very different areas in both geographic and climatic sense.

Table 1: The different regions and climate where the pink salmon is presently distributed (Forsgren et al., 2018, 5. juni)

Polar	Europe Asia North – and Central America
Temperate – boreal	Europe Asia North- and Central America
Temperate – nemoral	Europe Asia North- and Central America
Temperate – dry	North- and Central America - Arctic ocean - Northern-Pacific - The Northeast-Atlantic

Although the specie is distributed in such a range the species ecological effect is limited to relative oxygen rich clearwater rivers with permeable bottom substrate which increases hatching success (Forsgren et al., 2018, 5. juni).

[21] The mean weight for matured pink salmon in Norway is about 2kg for both male and female, but the biggest variation is found among the male O. gorbuschas (Gjelland, Sandlund, & Kart).

2.2 The case of the pink salmon in Norway

The occurrence of pink salmon in Norwegian waters is not a new discovery, but its recent increase in abundance has caught everyone by surprise. Both the Arctic red king crab and the pink salmon was introduced by the Soviet Union into the waters off the Kola peninsula in the same time period. The Arctic red king crab expanded into Norway around 1977[22] and increased in abundance in the 1990s (Artsdatabanken, 2018a). The pink salmon has also been observed in Norway in the years after introduction, but it did not show the same signs of establishment as that of Arctic red king crab. The Soviet Union introduced the pink salmon into the north eastern-Atlantic started by transporting more than 220 million of eggs from the rivers from the Russian part of the pacific to rivers that drained into the White Sea (Sandlund et al., 2019:1034). The eggs were collected from the Island of Sakhalin (48°N) (Sandlund et al., 2019:1036). The Sakhalin batch were placed in local hatcheries, and in the spring of 1957, 3,5 million fry were released into rivers draining to the White Sea after the yolk-sac had been absorbed (Sandlund et al., 2019: 1036)[23]. The Sakhalin batch failed to natural reproduce. It was assumed that the lack of natural reproduction was because the batch originated from rivers that where located too far south (Sandlund et al., 2019:1036). The stocking activity in northwest Russia started up again in 1985, with eggs from an odd year broodline. This time the eggs were imported from a more northern locality (the river Ola) and was incubated in local hatcheries before being introduced in 1986 (Sandlund et al., 2019: 1036). The stocking activity was repeated in 1998 with a release in 1990. The river Ola batch resulted in successful natural reproduction by odd-year pink salmon in the White Sea Rivers (Sandlund et al., 2019:1036). The same was attempted with an even year broodline, but without apparent success. The Soviet Unions (later Russia) introduction of pink salmon into the rivers draining to the White sea was over a long period of time and continued in some degree up to 2001, but in varied numbers (Forsgren et al, 2018, 5. juni)[24].

An expansion of pink salmon occurred from the waters off Kola Peninsula into two Norwegian rivers in eastern-Finnmark in the 1960s. The initial introduction led to large catches of adult O. Gorbuscha in the following year. These pink salmon didn't show signs of

[22] The Arctic red king crab was first detected in Varanger in 1977.

[23] There was a preceding attempt of introduction in the 1930s but was stopped after a lack of success (Forsgren et al., 2018, 5. juni) before it started up again in 1956. There's some incoherency in the literature according to when the first introduction took place, but this finding is based on information gathered from artsdatabanken.no

[24] There has been one known occasion with attempt of introducing pink salmon by stocking activity in Norway. This was in Søgneelva (58°N) in 1979, but it didn't result in any reported captures in the following years (Sandlund et al., 2019: 1036).

self-producing and was considered non-established (Mo et al., 2018:5). As to why they didn't become established, a lack of adaption to climatic condition and time of spawning are possible explanation, but this has not been substantiated (Mo et al., 2018:5). The low number of observed salmon remained until a sudden increase in 2017. This sudden increase of pink salmon was highest in Norway compared to other countries in the northern Atlantic region. In 2017 pink salmon was observed in 272 Norwegian rivers, and more than 5800 was either caught as bycatch or deliberately killed (Mo et al., 2018:5). A high amount of pink salmon also occurred in 2019 but the numbers are still being processed. It has previously been assessed that the odd year broodline is the strongest. The increase in 2017 and 2019 of pink salmon support that statement. The increase has never been as high as in 2017, but "since the beginning of 2000s, after the stockings ceased, variable numbers from a few to hundreds O. gorbuscha have been visually observed in rivers most years, but clearly high numbers in odd-years"(Mo et al., 2018:5). It can be assumed that increase in abundance of pink salmon in Norway comes from natural reproduction since Russia has stopped the stocking activity (Sandlund et al., 2019:1048). The theories that offers some explanations to the increase of abundance of pink salmon in the northern Atlantic are currently mere speculation. A combination of successful spawning in Russian as well as some northern Norwegian rivers in 2015, favourable river temperatures for hatching and smolt migration, and favourable conditions for O. gorbuscha in the sea can be part of the explanation (Mo et al., 2018: 6). There are uncertainties in this case, but more favourable conditions for pink salmon have some merit. There has been found a correlation between abundant return of pink salmon and ocean-surface temperature in the northern-Atlantic and Barents Sea (VKM,2020:14).

2.3 Morphology and colouring

The pink salmon also goes by name the humpback salmon (often shortened to humpie) due to the morphological changes of the male during spawning (Forsgren et al., 2018, 5.juni). During spawning the male develops a humpback in front of their dorsal fin. Other notable changes also occur on the male during spawning are enhancement of the jaw with a marked hook on the upper jaw called a kype, and a change in colouring (Forsgren et al., 2018, 5. juni). In the ocean phase it's dark on its back, silvery along the sides of the body with a white belly's, and suitable slim physique for the ocean environment (Forsgren et al., 2018, 5. juni). This colouring and physique are similar for both male and female in the ocean stage. Adult female and male pink salmon also develop black oval spots on their back and tails. The large oval spots distinguish them from native salmonids in Norway, along with the long base of the anal

fin (VKM et al., 2020:27). The scales are also smaller than other salmonid species in Norway making it more similar in appearance to Arctic charr (VKM et al., 2020:27). Another notable characteristic of the pink salmon is that the mouth is white, but the tongue and gums are black (VKM et al., 2020:27).

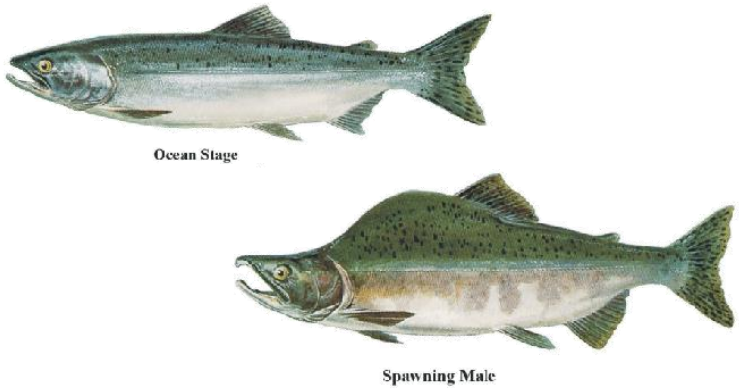

Figure 1 illustration of a pink salmon in the ocean and a male pink salmon in the freshwater stage. Note the humpback and enhanced jaw and kype [25]

After the return to freshwater there are changes in colouring of the pink salmon, this is in addition to the spawning male's development of the hump and kype. The male adults turn from silver to brown, before turning black on its back with a white belly. Female pink salmon also has this white belly, but the upper body turns olive with patches or bars that can be lavender or dark gold (VKM et al., 2020:28).

2.4 Lifespan and spawning

The Pink Salmon is an anadromous species that spends a brief amount of its life in freshwater (Sandlund et al., 2019:1035). It has a 2-year lifecycle and return to freshwater at the end of it to spawn (Sandlund et al., 2019:1035). The pink salmon dies shortly after spawning and exists in odd year- and even year broodlines (Sandlund et al., 2019:1035). The fish that was hatched in odd-years will return after one winter to their native rivers to spawn in another odd-year before dying, and the same goes pink salmon of the even-year broodline (Sandlund et al., 2019: 1035). Since, they spawn in different year and the odd year broodline appears stronger in Norway there has been conducted research about potential genetical differences between broodlines. There been few indicators of genetical diffrences; "the two broodlines are

[25] Illustration derived from https://commons.wikimedia.org/wiki/File:Ocean_stage_and_spawning_pink_salmon.gif. The illustration is allowed for reuse.

reproductively isolated from each other, but still the genetic differences between them is restricted…"(Sandlund et al., 2019:1035).

The spawning time of the pink salmon is usually in late summer between July- and mid-October. In Finnmark in the northern parts of Norway the pink salmon travels up the rivers to spawn in the period of mid-July/beginning of August (Forsgren et al, 2018, 5. juni). Its previous failure to reproduce has been linked to their late time of spawning. Their spawning ground are often in the lower region of the rivers although that can vary. During spawning the females buries a high number of tiny eggs into the gravel of the riverbed[26], and the fertilized eggs hatch into alevins with large yolk sacs during the winter/early spring (Sandlund et al., 2019: 1035). The females can lay up to 1200-1900 eggs[27]. The amount of eggs depends upon the size of the female, and they can protect their spawning site both before and for a few days after spawning before dying (VKM et al., 2020:31). The fry comes up from the gravel of the riverbed when it is about 29-33mm (Gjelland et al.). The fry usually hatch the following spring around the period of March/May (Sandlund et al., 2019: 1035).

Figure 2 and Figure 3 Pink salmon caught by targeted effort of fishing with mesh in the Reisa river in the summer of 2019. The targeted effort was executed by volunteers from the local community. Permission for use granted by Reisa Elvelag.

A juvenile migration occurs shortly after hatching as they don't stay in the river before exchanging freshwater for saltwater. It hatches fully adapted for the ocean environment (Forsgren et al, 2018, 5. juni). There is some discussion to how long the fry stays in rivers and if they feed there. Observations made in Finnmark indicates that this can vary (Sandlund et

[26] These nests are called redds (VKM et al., 2020:31)
[27] The eggs are about 6 mm in diameter

al., 2019: 1045) The fry does spend a few weeks (or even months) (Sandlund et al., 2019: 1035) in the estuary upon descending from the river, before it transitions into the sea (Forsgren et al, 2018, 5. juni). Feeding in freshwater during the juvenile migration seems to vary depending between and within rivers (VKM et al, 2020:32). Through it seems more likely during long migrations routes in freshwater (VKM et al, 2020:32). The main competition that can occur in the rivers is between adult pink salmon and other salmonids, could be for spawning grounds and not for food.

2.5 Capacity for expansion in Norway

The pink salmon has up to now been risk assessed by the Norwegian biodiversity information centre[28] as being high risk but with low ecological impacts (Forsgren et al., 2018, 5. juni). It's assessed as a species with low ecological impact because there is no known impact regarding interactions with other species. There's a lack of information about its potential negative impacts on the Atlantic salmon or diseases it might carry. The Atlantic salmon spawns later in the summer and usually further down in the rivers, but that there exists some interaction cannot be discounted. There's some uncertainty regarding its ecological effects on native species within the next fifty years (Forsgren et al., 2018, 5. juni). The uncertainty is connected to competition for spawning grounds or how the pink salmon further adapts along the Norwegian coast. In Alaska there have been a population of pink salmon where genetic changes have occurred, and where the population spawn two weeks earlier than forty years ago. The temperature of the river has increased by one degree in that time period (Forsgren et al., 2018, 5. juni). This can indicate an adaptability towards climate change, so by taking this potential for genetic changes into account it can be harder to predict how the specie might develop along the Norwegian coast in the future.

Despite it being assessed as having low ecological effect the pink salmon is still classified as high risk because of its potential to spread. Pr. 29 September 2017 the pink salmon was captured in over 230 watercourses along the Norwegian coast (Forsgren et al., 2018, 5. juni). Its expansion rate has been estimated with some uncertainty to be above 500 m/pr. year in the risk assessment (Forsgren et al., 2018, 5. juni). It's ability to reproduce is limited to certain climatic condition, but pr. 2019 its known distribution area in Norway is about 72 9022 km^2. The abundance of it is higher in the northern region of Norway (areas of Finnmark and

[28] The Norwegian biodiversity information centre (NBIC) is usually known by its Norwegian name of Artsdatabanken. Their main task is to make updated information about fauna and flora in Norway easily accessible.

Troms), and this was also where the first observation of the pink salmon took place (Forsgren et al., 2018, 5. juni). During the introduction period there was an increase in catches of pink salmon in the eastern parts of the region Finnmark, but the increase didn't continue (Forgren et al, 2018, 5. Juni).

In 2016 the mapping showed that the pink salmon had expanded to 28 rivers in eastern parts of Finnmark with proof of recruitment in some of them (Forsgren et al., 2018, 5. juni). It had also spread to further south of Finnmark and regions of Troms and Nordland. In the regions of Troms and Nordland there was a low number of pink salmon, but found in a total of 13 localities (Forsgren et al., 2018, 5. juni). This spread had in 2017 continued further south of the Norway and into other European countries with reports of bigger catches of pink salmon in more rivers. Fry was found as far south as in Jølstra in Sogn and Fjordane (Forsgren et al., 2018, 5. juni). It not reported that natural recruitment occurs in all of localities reported, but it is a statement to the expansion rate of the pink salmon. The risk assessment conducted by the NBIC have estimated that the potential distribution of the pink salmon in 50 years can be the whole of Norway which is connected by the sea (Forsgren et al., 2018, 5. juni). The only areas where it is not predicted to spread to in Norway within the next fifty year are inland areas without sea borders. In Norway it appears as though the odd-year class is the strongest with a bigger abundance, but in recent years in the even-years there has also been significant numbers of catches of pink salmon from this broodline (Sandlund et al., 2019: 1033).

It has been concluded based on findings that the pink salmon has a higher straying rate than other *Onchohychys* species (Sandlund et al., 2019:1046). Hatchery produced pink salmon has also been reported with a higher straying rate than to naturally produced (Sandlund et al., 2019:1046). The straying rate might explain parts of the species recent ability to invade the Norwegian coast in this degree and rate. The pink salmons ability to expand can cause challenges for the Norwegian management system, as stated by Sandlund et al. "Secondary spreading is perhaps the greatest challenge for management, because it becomes impossible to contain unwanted species with a large ability to disperse" (2019:1034).

2.6 Potential impacts of the O. gorbuscha in Norwegian waters

"The introduction of non-native species is considered one of the major threats to native biodiversity and ecosystem services" (Sandlund et al., 2019). When there is an introduction several scenarios can happen like that the introduced species perishes or reproduction is successful for a few generations. A likely scenario that seem to be the case of the pink salmon in the northern-Atlantic is that there have been a low population that have remained

undetected. It then has had a sudden increase and started secondary spreading. The species then establishes itself directly and further increase in numbers although it cannot be concluded yet that it may/or is becoming dominant in this recipient environment. A “boom-and-bust” development can also be an ending to this kind off scenario (Sandlund et al., 2019: 1034). The impact of species introductions is associated with the ability of the established alien species to spread and establish in more localities than the original target locality. (Sandlund et al., 2019: 1034)

As the pink salmon spawns earlier than for example Atlantic salmon, but the spawning grounds can be still led to a degree of interaction between them. They prefer similar spawning grounds and there have been observations of pink salmons attacking Atlantic salmon that are at the same spawning sites (Sandlund et al., 2019: 1048). If the fry as well stay longer in the rivers to feed there can be create problems regarding “availability if space and available zoobenthos for other salmonids”(Sandlund et al., 2019: 1050) It can also carry diseases, but at this stage there’s too little research done on that matter. How post spawning pink salmon carcasses may impact the microenvironment of the river is also discussed as potential impacts. Some thinkable scenarios may be “rotting fish may cause local oxygen deficiencies, reducing survival of incubating fish eggs in the substratum” or there might be some benefits as “the decomposing carcasses may contribute to increased invertebrate production in the river. This could benefit older native salmonid juveniles during late autumn and winter, and possibly also newly hatched fry in the spring” (Sandlund et al., 2019: 1049).

There are many unknowns in the case of the pink salmon in Norway. The possible negative impacts will be further elaborated upon in chapter 4.3 dedicated to the risk assessments. It is a relatively recent rise in abundance which makes it a new challenge for the management system to cope with. How the legal framework management system surrounding alien species is build up will be covered in the following chapter.

3 The legal framework and management institutions

The national and international instruments are of importance in this thesis. This involves both international agreements and national legislations in Norway that deals with alien species. Since these rarely are species specific and therefor has a broader application, there is none that directly refers to the pink salmon. This chapter has the purpose of providing an overview of the legal framework, that both strengthens and limits the Norwegian management systems ability to manage alien invasive species such as the pink salmon.

3.1 International agreements

There are several legally binding international agreements that refer either directly or indirectly to alien or alien invasive species. The international agreements can cover different aspects, for example prevention, while some has a focus on specific ecosystems. It has also been criticized for not being comprehensive or consistent; "Treatment of alien species in aquatic ecosystems in global multilateral agreements is neither comprehensive nor entirely consistent. Marine ecosystems currently have somewhat better coverage than freshwater ecosystems" (Moore, 2005: 51).

The United Convention on the Law of the Sea (further referred to as UNCLOS) of 1982[29] is considered as the foundation that other international agreements regarding the seas is built upon. UNCLOS has provisions that pertains to both alien species and Exclusive Economic Zone (EEZ). EEZ is relevant to the exploration, exploitation, management and conservation of marine resources. The UN Fish Stock Agreement (further referred to as UNFSA)[30] has the objective of effective implementation through the framework of UNCLOS to ensure sustainable use, and long-term conservation of straddling- and highly migratory fish stocks [31]. International, regional or sub-regional cooperation through Regional Fisheries management Organizations (RFMOs) is further addressed in UNFSA.

In UNCLOS the exclusive economic zone (EEZ) for Coastal States is given under Part V of the convention agreement. An exclusive economic zone is defined by article 55 of UNCLOS as "an area beyond and adjacent to the territorial sea". This area is subject to a specific legal regime, established under this Convention. Coastal States and third countries are governed by

[29] United Nations convention on the law of the sea (UNCLOS), Montego Bay, 10-12-1982 (entered into force 16-11-1994) nr 1 Multilateral

[30] Agreement for the implementation of the provisions of the United Nations Convention on the Law of the Sea relating to the conservation and management of straddling fish stocks and highly migratory fish stocks (UNFSA), New York, 04-08-1995 (entered into force 11-12-2001) nr 1 Multilateral

[31] Article 2 of UN Fish Stock Agreement of 1995

the relevant provision of this convention. Establishing EEZs is a method of controlling fishing effort, in a world where advances made in technology has led to an increased harvest capacity in a high rate that can lead to overfishing. The provisions pertaining to EEZ defines sovereign rights, jurisdiction, duties and breadth. An economic exclusive zone gives a coastal State specific sovereign rights, jurisdiction and duties, which is given under article 57 of UNCLOS[32]. Article 57 A) of UNCLOS gives a costal State sovereign rights in their EEZ over managing, exploiting, exploring and conserving natural resources. This entails both living- and non-living organisms, of the waters above the seabed, and on the seabed and its subsoil. The sovereign right also includes other activities for economic purposes and exploration of the zone. Norway has established three of these zones. This were established in accordance with article 57 of UNCLOS, which states that "The exclusive economic zone shall not extent beyond 200 nautical miles from the baseline from which the breadth of the territorial sea is measured". The first established zone is the Norwegian economic zone (NØS), which extends around the mainland of Norway[33]. The second is a fisheries protection zone by Svalbard[34]. The third is a fishery zone by Jan Mayen[35](Regjeringen.no, 2014, 12.03). These were established under the Norwegian Economic Zone Act of 1976[36]. This amounts to a vast amount of area of which Norway has the primary interest and responsibility for sustainable utilization of the natural resources within these zones. According to article 56 part 1 (B), Norway as a coastal State has jurisdiction within their exclusive economic zone with regard to: *"(i) the establishment and use of artificial islands, installations and structures; (ii) marine*

[32] Article 56 of the United Nations Convention on the Law of the Sea of 1982
Rights, jurisdiction and duties of the coastal State in the exclusive economic zone
1. In the exclusive economic zone, the coastal State has:
(a) sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the seabed and of the seabed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds;
(b) jurisdiction as provided for in the relevant provisions of this Convention with regard to:(i) the establishment and use of artificial islands, installations and structures;(ii) marine scientific research;(iii) the protection and preservation of the marine environment.
(c) other rights and duties provided for in this Convention.
2. In exercising its rights and performing its duties under this Convention in the exclusive economic zone, the coastal State shall have due regard to the rights and duties of other States and shall act in a manner compatible with the provisions of this Convention.
3. The rights set out in this article with respect to the seabed and subsoil shall be exercised in accordance with Part VI.
[33] The Norwegian Economic Zone (Norsk Økonomisk Sone (NØS)) came into force 1st of January 1977
[34] The fishery protection zone by Svalbard came into force 15th of June 1977
[35] The fishery zone by Jan Mayen came into force 29th of May 1980
[36] Økonomiske soneloven – øksonl (1976). lov om Norges økonomiske sone (LOV-1976-12-17-91). Link: https://lovdata.no/dokument/NL/lov/1976-12-17-91?q=lov%20om%20%C3%B8konomisk%20sone

scientific research; (iii) the protection and preservation of the marine environment;". The coastal States also has other rights and duties provided under the provisions of this agreement and shall have due regard for other States rights and freedoms.

Part V of the United Nations Law of the Sea convention of 1982 article 66 pertains to anadrome species. Article 66 (1) states that "*States in whose rivers anadromous stocks originate shall have the primary interest in and responsibility for such stocks.*". The primary interest and responsibility will be with the native fauna and flora, which the non-native organisms can negatively impact. Article 66 (4) of this paragraph pertain to commitment of collaboration between State of origin and other States in cases where anadromous stocks migrates beyond and/or across borders of EEZs[37]. In section 5 of article 66 of UNCLOS it is required by State of origin and Other States to make arrangements for implementation of the provisions this article, and where appropriate through Regional Fisheries Organizations (RFMOs)[38].

RFMOs are intended to facilitate cooperation and ensure compliance on shared, straddling or highly migratory stocks on the high sea, and sometimes inside exclusive economic zones (EEZ). UNFSA is an agreement put in place for the implementation of the provisions from UNCLOS regarding shared, straddling or highly migratory stocks of the high Sea. In UNFSA RFMOs are further elaborated upon through article 8. An RFMO that is of interest and is further elaborated upon in a section about international cooperation is The Convention for the conservation of wild salmon in the North Atlantic Ocean of 1982 (NASCO). This RFMO is of interest for this thesis, because there is uncertainty regarding if the pink salmon interact or has effects on the native wild salmon population. The convention's objective is to " promote conservation, restoration, enhance and rationally manage wild salmon through international co-operation taking account of the best available scientific information" (NASCO).Through UNFSA the precautionary approach is further specified for shared, straddling and highly migratory stocks through article 6. This introduces and allows for a precautionary approach for shared-, straddling- or highly migratory fish stocks on the high Sea.

[37] Article 66 (4) of UNCLOS
In cases where anadromous stocks migrate into or through the waters landward of the outer limits of the exclusive economic zone of a State other than the State of origin, such State shall cooperate with the State of origin with regard to the conservation and management of such stocks.
[38] Article 66 (5) of UNCLOS
The State of origin of anadromous stocks and other States fishing these stocks shall make arrangements for the implementation of the provisions of this article, where appropriate, through regional organizations.

Pertaining to alien- and new species, the Law of the Sea article 196 (1) asserts that states should take all necessary measures to prevent, reduce and control introduction of technology, or alien- and new species that can induce significant or harmful changes to marine environment under their jurisdiction. It does not refer to how each state should apply these measures to fulfil their obligation to protect and preserve marine environments under article 235(1) of UNCLOS.

Textbox 2. CBDs definition of biodiversity:

The CBD describes the use of the term of biological diversity for the purpose of the convention in article 2 as; "Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems"

An international agreement that has a more direct focus on biodiversity in relation to alien species is the Convention on Biodiversity (1992)[39]. The objectives of the convention is conservation of biological diversity, sustainable use and sharing of the benefits arrived from utilized resources (CBD, 1992). The need to address the impact of alien species is expressed through article 8 (h), member parties are obliged to "Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species"(CBD, 1992). Further guidelines is given article 9 of the CBD "that contracting members shall pursue the entirety of the article as far as possible and as appropriate and predominantly for the purpose of complementing in-situ measures" (1992). Article 8 (h) and 9 of the CBD does not provide a consistent guideline for States, as to types of measures and to what it can be considered possible and appropriate. What is considered possible or appropriate is up for interpretation. A three-stage hierarchical approach is given as a guiding principle II of CBD COP 6 Decision VI/23[40]. It is first mentioned that prevention is a priority. Prevention is the most cost-effective and desirable for the environment, rather than implementing measures after introduction or establishment of invasive alien species. If introduction or establishment has occurred than eradication is a preferred response (principle 13). This should be done as soon as feasible and if it is also reasonable. This entails that a State has resources at its disposal to implement eradication measures. If the preferred response isn't feasible or reasonable then containment (principle 14) or long-term control (principle 15) measures should be implemented.

[39] CBD (1992). Convention on biological diversity (CBD),05-06-1992 nr 1 Multilateral (entered into force 29-12-1993) Rio de Janeiro. Retrieved from: https://lovdata.no/dokument/TRAKTATEN/traktat/1992-06-05-1?q=cbd
[40] *Guiding Principles for the Implementation of Article 8(h)* CBD, Haque, UNEP/CBD/COP/6/20, VI/23, 2002

A commonality between several of the international agreements is the precautionary approach. The precautionary approach is a guiding principle in CBD COP 6 Decision VI/23. Guiding principle I of CBD COP 6 Decision VI/23 states that:

> "Given the unpredictability of the pathways and impacts on biological diversity of invasive alien species, efforts to identify and prevent unintentional introductions as well as decisions concerning intentional introductions should be based on the precautionary approach, in particular with reference to risk analysis,…"

The precautionary approach should also be applied when considering the three-stage hierarchal approach of eradication, containment or control. Guiding principle I of CBD COP 6 Decision VI/23 also states that *"lack of scientific certainty about the various implications of an invasion should not be used as a reason for postponing or failing to take appropriate eradication, containment and control measures"*. The precautionary approach view alien or foreign species in regard with their potential impact on biodiversity in marine ecosystems. Although these agreements address the issue of alien or foreign species there are certain weaknesses, for example when creating a coherent approach to management of alien species.

> "The conservation treaties address alien species in the context of species and ecosystem health and function but tend to be weak on issues such as early warning, monitoring, and transboundary cooperation. Where such provisions exist, they are general ones that are not alien-specific."(Moore, 2005: 52).

Other relevant international agreements regarding alien species is the Bern convention[41]. Article 11 2(b) of the Bern convention requires all parties "to strictly control the introduction of non-native species"(Council of Europe, 1982). The Convention on the Conservation of Migratory Species of Wild Animals (CMS)[42] article III 4(c) states that Range States of a migratory species shall endeavour "*to the extent feasible and appropriate, to prevent, reduce or control factors that are endangering or are likely to further endanger the species, including strictly controlling the introduction of, or controlling or eliminating, already introduced exotic species.*". What qualifies as a Range state is listed in article I(c) " *'Range State' in relation to a particular migratory species means any State (…) that exercises jurisdiction over any part of the range of that migratory species, or a State, flag vessels of which are engaged outside national jurisdictional limits in taking that migratory species;*". The CMS uses the term "introduced exotic species" instead of "alien species" used in UNCLOS and the CBD. To prevent, reduce or control factors like introduced exotic species is

[41] Convention on the Conservation of European Wildlife and Natural Habitats (CMS), Bern, 19-09-1979 (entered into force 01-06-1982) nr 1 Multilateral

[42] The Convention on the Conservation of Migratory Species of Wild Animals (CMS), Bonn, 23-06-1979 (entered into force 01-11-1983) nr 1 Multilateral

limited by the article to those introduced exotic species that are endangering or are likely to endanger migratory species. No apparent action is required by the CMS, if an alien- or introduced exotic does not or can endanger migratory species.

3.2 Norwegian legislation and framework

In the Constitution of the Kingdom of Norway (1814)[43] section 112 it is stated that:

> "Every person has the right to an environment that is conducive to health and to a natural environment whose productivity and diversity are maintained. Natural resources shall be managed on the basis of comprehensive long-term considerations which will safeguard this right for future generations as well…"

The Norwegian Nature Diversity Act of 2009[44] can be seen in connection with this section of the constitution. The Nature Diversity Act of 2009[45] is the main national legislation regarding foreign organisms. The definition of terms used in the act is found in chapter I section 3. Terms like nature diversity covers biological-, landscape and geological diversity. Alien/foreign organisms are defined by section 3 a) of The Nature Diversity Act of 2009 as *"an organism that does not belong to any species or stock that occurs naturally within an area"*. The purpose of the Act is stated in chapter I section 1 of the Nature Diversity Act:

> "…to protect biological, geological and landscape diversity and ecological processes through conservation and sustainable use, and in such a way that the environment provides a basis for human activity, culture, health and well-being, now and in the future, including a basis for Sami culture[46]"

It has a generational perspective that is equivalent to that of section 112 of the Constitution. Diversity and ecological processes are to be managed through sustainable use and conservation, and it such a way that it is conducive towards present- and future use.

In chapter II the national management goal for ecosystems, habitats and species are made enforceable. Chapter II of the Nature Diversity Act of 2009 contains the general provisions. Section 4 of the Nature Diversity Act of 2009 contains the two management objectives for habitat types and ecosystems. The first objective is to "*maintain the diversity of habitats within their natural range and the species diversity and ecological processes that are characteristic of each habitat type*…" (Section 4 of the Nature Diversity Act of 2009). The

[43] Kongeriket Norges Grunnlov mv. Grl (LOV-1814-05-17)
[44] Lov om forvaltning av naturens mangfold mv. naturmangfoldloven (LOV-2009-06-19-100)
[45] Last amendment came into force 01.01.2016, alongside the regulation for foreign organisms.
[46] Lov om forvaltning av naturens mangfold mv. (naturmangfoldloven) §1. (Lovens formål) er at naturen med dens biologiske, landskapsmessige og geologiske mangfold og økologiske prosesser tas vare på ved bærekraftig bruk og vern, også slik at den gir grunnlag for menneskenes virksomhet, kultur, helse og trivsel, nå og i fremtiden, også som grunnlag for samisk kultur.

second objective is "… *also to maintain ecosystem structure, functioning and productivity to the extent this is considered to be reasonable*" (Section 4 of the Nature Diversity Act of 2009[47]).

The purpose, management goal and objectives portray the view that does not occur naturally within an area is a threat to the existing biodiversity and ecological processes. Maintaining structure, functioning and processes of current ecosystems expresses an objective of conservation, of which alien species can interfere with. This objective extends to what can be considered reasonable. The management goal for species within Norwegian jurisdiction is found in chapter II section 5 of the Nature Diversity Act. The management objective for species does not extend to foreign organisms such as the pink salmon, which is stated in paragraph 2 of section 5 of the Nature Diversity Act of 2009.

The Nature Diversity Act follows the precautionary approach (Chapter II § 9 of the Nature Diversity Act). This is a continuation of the basic principles put forward by national- and international law. Principles such as the precautionary approach can be traced back to principle 15 of the Rio Declaration on Environment and Development of 1992:

> "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (CBD).

Two criteria need to be present for the precautionary to be applied; 1. There aren't sufficient information about the natural diversity and/or effect on the natural diversity, 2. the aim is to avoid possible substantial damage to the natural diversity (Miljøverndepartementet, 2012:64). Another principle found in the Nature Diversity Act of 2009 section 10 is the requirement of following the ecosystem-based management. Ecosystem-based management is a wide concept where all the pressures on the ecosystem is attempted included in the management. This includes management of human activities as an unsegregated part of the ecosystem. Further explanation of what the concept entails is found in CBD COP 5 decision V/6.

[47] Lov om forvaltning av naturens mangfold mv. (naturmangfoldloven), § 4.(forvaltningsmål for naturtyper og økosystemer)
Målet er at mangfoldet av naturtyper ivaretas innenfor deres naturlige utbredelsesområde og med det artsmangfoldet og de økologiske prosessene som kjennetegner den enkelte naturtype. Målet er også at økosystemers funksjoner, struktur og produktivitet ivaretas så langt det anses rimelig.

Other basic principles concerning foreign organisms is the sectoral responsibilities and user-pays principle. Sectoral responsibilities entail: "All sectors of society and actors have an independent responsibility to integrate environmental considerations into their activities"[48]. There has been developed a national cross-sectorial strategy[49] to enhance cooperation and competence in relation to prevent or control foreign species, but sectorial responsibilities still remains (Miljøverndirektoratet, 2007). The user-pay principle is found in the Rio Declaration principle 16 and in Norwegian policy documents. The principle entails that the a responsible entity or person will be liable for the cost- of environmental damage caused be introduction (Regjeringen.no, 2007:35). This principle can be found in the Norwegian legislation under the Nature Diversity Act of 2009.

The Nature Diversity Act of 2009 chapter IV concerns alien organisms. Section 29 of the Nature diversity Act of 2009 prohibits import of living or viable organism to Norway without permission granted by competent authority. General rules regarding the release of organisms or species into the environment is given under section 30 of the Nature Diversity Act of 2009. Section 28, first paragraph of the Nature Diversity Act of 2009 demands duty of care when realising foreign organisms that either living or viable into the environment and shall seek to prevent adverse impacts on biological diversity. Duty of care is fulfilled if release is done in accordance with permit issued by public authority [50]. The duty of care involves that a person that is performing an activity should be familiarised with the risk involved with set activities. This presupposes that information is provided by the management agencies (Miljøverndepartementet, 2012:13). It is expected more diligence to the duty of caution by management agencies than by individuals (Miljøverndepartementet, 2012:13). The duty of care applies to harm of diversity that is in violation with section 4 and 5 of the Nature Diversity Act of 2009 (Miljøverndepartementet, 2012:13). The course of action if the demands of duty of care is breached in reference to intentional or accidental release of foreign organisms is found in section 28, third paragraph of the Nature Diversity Act of 2009,

[48] Norwegian ministry of the Environment (2007), *Strategy on Invasive Alien Species.* Retrieved from: https://www.regjeringen.no/globalassets/upload/md/vedlegg/planer/t-1460_eng.pdf

[49] Miljøverndirektoratet. (2007). *Tverrsektoriell nasjonal strategi og tiltak mot fremmede skadelige arter*. Miljøverndepartementet, Retrieved from https://www.regjeringen.no/globalassets/upload/md/vedlegg/planer/t-1460.pdf

[50] Lov om forvaltning av naturens mangfold mv.(naturmangfoldloven) § 28. (krav til aktsomhet)
Den som er ansvarlig for utsetting av levende eller levedyktige organismer i miljøet, skal opptre aktsomt, og så langt som mulig søke å hindre at utsettingen får uheldige følger for det biologiske mangfold. Utføres en utsetting i henhold til en tillatelse av offentlig myndighet, anses aktsomhetsplikten oppfylt dersom forutsetningene for tillatelsen fremdeles er til stede.

> "If there is damage to biodiversity or the danger of serious damage to biodiversity as a result of the release or accidental release of foreign organisms, the person responsible shall immediately notify the authority under this Act and take measures in accordance with §§ 69 and 70, unless such reporting and action obligation follows from other law"[51].

Chapter IX of the Nature Diversity Act of 2009 concerns sanctions. Section 69 regards measures to remedy or mitigate the impact of unlawful activities. states that the authorities in charge can impose the responsible party to rectify or cease matters that is at breach with the law or decisions of the Nature Biodiversity Act[52]. The measures that can be imposed if deterioration has already occurred is stated in section 69, second paragraph of the Nature Diversity Act[53]. These are measures that will hinder further deterioration and if possible, restore previous state of diversity. The measures are collection, clearing, removal, levelling or other appropriate measures. Measures that can themselves cause environmental degradation of any significance shall only be implemented after consent of the authority under the law or orders under the first paragraph. The extent to which the duty of caution and the user-pay principle is given in section 69, third paragraph of the Nature Diversity Act:

> "The duty to take preventive, remedial or restorative action does not apply to the extent that it would be particularly unreasonable in the light of the cost and effects of the measures, the environmental impacts of the contravention and the offender's fault and financial situation."

The duty of prevention, rectification and restoration does not extend to a degree that would be unreasonable seen in relation with the mentioned circumstances[54]. In section 69, fourth

---

[51] Lov om forvaltning av naturens mangfold mv. (naturmangfoldloven) ledd 3 av § 28. (krav til aktsomhet)
Dersom det oppstår skade på biologisk mangfold eller fare for alvorlig skade på biologisk mangfold som følge av utsetting eller utilsiktet utslipp av fremmede organismer, skal den ansvarlige umiddelbart varsle myndigheten etter loven her, og treffe tiltak i samsvar med §§ 69 og 70, med mindre slik melde- og tiltaksplikt følger av annen lov

[52] Lov om forvaltning av naturens mangfold mv. (naturmangfoldloven) ledd 1 av § 69. (retting og avbøtende tiltak)
Myndigheten etter loven kan pålegge den ansvarlige å rette eller stanse forhold som er i strid med loven eller vedtak med hjemmel i loven.

[53] Lov om forvaltning av naturens mangfold mv. (naturmangfoldloven) ledd 2 av § 69. (retting og avbøtende tiltak)
Den som ved å overtre loven eller vedtak med hjemmel i loven forårsaker fare for forringelse av naturmangfoldet, skal sette i verk tiltak for å forhindre at slik forringelse skjer. Har forringelsen allerede inntrådt, gjelder plikten hindring av ytterligere forringelse og – om mulig – gjenoppretting av den tidligere tilstand for mangfoldet ved oppsamling, rydding, fjerning, planering eller andre egnede tiltak. Tiltak som i seg selv kan medføre miljøforringelse av noen betydning, skal bare iverksettes etter samtykke av myndigheten etter loven eller pålegg etter første ledd.

[54] Lov om forvaltning av naturens mangfold mv. (naturmangfoldloven) ledd 3 av § 69. (retting og avbøtende tiltak)
Plikten til forebygging, utbedring og gjenoppretting gjelder ikke i den utstrekning det i lys av kostnadene og virkningene av tiltakene, miljøvirkningene av overtredelsen og overtrederens skyld og økonomiske stilling, ville være særlig urimelig.

paragraph it is stated *"Measures implemented under this section may consist of the killing of alien organisms to which the contravention relates or the return of living organisms to their original location."*[55].

Section 70 of the Nature Diversity Act of 2009 refers to accidental damages to the environment caused by legal activity. According to section 79, first paragraph of the Nature Diversity Act of 2009:

> "If projects carried out in accordance with the Act or with decisions made under the Act prove to have substantial unforeseen impacts on biological, geological or landscape diversity, the person responsible shall take reasonable measures to prevent or limit damage or nuisance." [56].

The responsible part in the case of the pink salmon is not under the purview of Norwegian legislation. The pink salmon was not released into Norwegian territory but is a result of secondary expansion. Preventing or minimizing damage caused by alien species creates a challenge in this instance because of jurisdictional limitation. This is a challenge that shows the importance of international agreements that is coherent among States.

Along with the chapter IV of the Nature Diversity Act, regulation for foreign organisms came into full force in 01.01.2016. Its purpose according to section 1 of the regulations for foreign organism is "*…the regulations is to prevent the introduction, release and spread of foreign organisms that cause, or may cause, adverse consequences for the diversity of nature*"[57]. As the pink salmon is showing signs of already self-producing, establishing and expanding through the Norwegian coast it is not listed under as a forbidden species to import, release or trade under this regulation. According to section 2 of the regulation for foreign organism, "*The regulations apply to Norwegian land territory, including watercourses, in Norway's territorial waters and on Jan Mayen. The regulations do not apply to Svalbard*". The regulation for foreign organism is also enforceable in watercourses.

---

[55] Lov om forvaltning av naturens mangfold mv. (naturmangfoldloven) ledd 4 av § 69. (retting og avbøtende tiltak)
Tiltak etter denne paragrafen kan gå ut på avliving av fremmede organismer som overtredelsen gjelder, eller tilbakeføring av levende organismer til opprinnelsesstedet.

[56] Lov om forvaltning av naturens mangfold mv. (naturmangfoldloven) ledd 1 av § 70. (uforutsette miljøkonsekvenser av lovlig virksomhet)
Dersom det viser seg at tiltak i samsvar med loven eller vedtak i medhold av loven medfører vesentlige uforutsette konsekvenser for naturmangfoldet, skal den ansvarlige treffe rimelige tiltak for å avverge eller begrense skader og ulemper.

[57] Forskrift om fremmede organismer (2015). (FOR-2015-06-19-716). Link: https://lovdata.no/dokument/SF/forskrift/2015-06-19-716?q=forskrift%20om%20fremmede%20organismer

Other anadromous species like the Atlantic salmon is covered under Another act the Salmon Fish and Inland Fish Act of 1992[58]. This law complies with the Nature Diversity Act which is stated in the purpose of the Act *" ...to ensure that natural populations of anadromous salmonids, inland fish and their habitats as well as other freshwater organisms are managed in accordance with the Nature Diversity Act and so that nature's diversity and productivity are preserved..."*. Section 1 of the Salmon and Inland Fish Act of 1992 also states that this should be *"Within this framework, the Act shall provide a basis for the development of the stocks with a view to increased returns, for the benefit of licensees and anglers." Section 1 of the Salmon Fish and Inland Fish Act of 1992*"[59]. The pink salmon is not covered under this act due to be an alien species according to section 18 g) of the Nature Diversity Act of 2009. It is still considered useful to include based on the pink salmon can impact those species that are covered under this law.

3.3 The management institutions

The highest authority according to section 62, first paragraph of the Nature Diversity Act is the Government[60]. The Government can delegate authority to municipalities or management agencies in accordance with section 62, second paragraph of the Nature Diversity Act of 2009. This makes it possible for other government institutions to have execute authority through delegated power. Examples of government institutions that receive delegated authority are municipalities and Governor of the County (fylkesmann).

3.3.1 The highest administrative authority

The Norwegian ministry of Climate and Environment is responsible for the decisions of the Nature Diversity Act of 2009 (Miljøverndepartementet, 2012:6). Their responsibilities reside in safeguarding the entirety of the governments environmental policies. This entails coordination and follow up on the governments environmental goals and results (Regjeringen.no, 2014, 13.10). As the highest administrative authority, they delegate power to other government bodies, and supervise them. The Ministry of Climate and Environment supervise the condition of the environment and if regulation and laws are upheld according to

[58] lakse- og innlandsfiskloven – laksfl (1992). Lov om laksefisk og innlandsfisk (LOV-1992-05-15-47). Link: https://lovdata.no/dokument/NL/lov/1992-05-15-47?q=lakse%20og%20innland

[59] Lov om laksefisk og innlandsfisk § 1. (Lovens formål)
Lovens formål er å sikre at naturlige bestander av anadrome laksefisk, innlandsfisk og deres leveområder samt andre ferskvannsorganismer forvaltes i samsvar med naturmangfoldloven og slik at naturens mangfold og produktivitet bevares. Innenfor disse rammer skal loven gi grunnlag for utvikling av bestandene med sikte på økt avkastning, til beste for rettighetshavere og fritidsfiskere.

[60] The King of Norway is referred to in the act as the highest authority, but the governments are the presiding authority. The King of Norway usually abide with goverment decisions, and usage of the term 'King of Norway' in legislation is an old custom.

section 63, first paragraph of the Nature Diversity Act of 2009[61]. Supervision entails surveillance and control by the Ministry of Climate- and Environment. According to section 63, paragraph 1 of the Nature Diversity Act, the Ministry should ensure that supervision is carried out in such a degree that violations can be uncovered.

3.3.2 Management institutions with delegated power

The Norwegian Environment Agency is to be alerted if foreign organism that can be a possible threat to biodiversity has been unintentionally or intentionally released. If there are any breach with the enforcement of the law the responsible party is liable to stop or correct the situation according to section 69 of the Nature Diversity Act of 2009 and section 19 of the regulations for foreign organism from 2016. In the case of the pink salmon there are jurisdictional issues that complicates enforcement of this paragraph as the responsible party is of another nation. The Norwegian Ministry of Climate and Environment is the appeal body. The authority to supervise if environmental laws are upheld can be further delegated to the Norwegian Nature Inspectorate.

The Norwegian Nature Inspectorate (SNO) is a part of the Norwegian Environment Agency. SNO is described as the Norwegian environmental managements operative field body (Miljødirektoratet, u.d.). They supervise laws as The Nature Diversity Act of 2009 and the Salmon- and Inland Fish Act of 1992 are upheld both on public- and private property. SNO "exercise authority pursuant to the Nature Inspectorate Act under the Ministry of Climate and Environment" (Miljødirektoratet, u.d).Their tasks involves control, information and guidance, as well as registration, documentation, care and facilitation (Miljødirektoratet, u.d.). This requires cooperation and coordination with other actors within the environmental protection field. The information that is gathered by supervision will be used for execution or sanctioning.

[61] Lov om forvaltning av naturens mangfold mv. (naturmangfoldloven) § 63. (tilsyn)
Departementet fører tilsyn med miljøtilstanden og med at bestemmelsene gitt i og i medhold av loven blir overholdt. Tilsynsmyndigheten avgjør på hvilke områder det skal føres tilsyn. Tilsynsmyndigheten skal utøve kontroll i et slikt omfang at den kan avdekke regelbrudd.

Under utøvelse av tilsynet skal den som blir kontrollert eller den ansvarlige for virksomheten gi tilsynsmyndigheten nødvendig bistand og opplysninger. Tilsynsmyndigheten kan stanse personer, fartøyer og motorkjøretøyer dersom dette er nødvendig for utøvelsen av tilsynet. Det skal legges vekt på å føre et så effektivt tilsyn som forholdene tilsier med minst mulig belastning for miljøet.

Myndighetene skal gjennom råd, veiledning og opplysning arbeide for å fremme formålene med loven her.

The Norwegian Directorate of the Environment has the responsibility of managing the regulation for foreign organisms. This entail implementing measures, managing and enforcing regulation in relation with introducing, spreading, controlling and eradicating alien species (Miljødirektoratet, n, u.d). The Norwegian Directorate of the Environment inhabits the role of appellant for decision reached by the municipality, unless otherwise decided. The county governor[62] remain the right to appeal decision reached by municipalities or management agencies with delegated power (section III § 62 of the Nature Diversity Act of 2009). The directorate of the Environment and the County Governor has an important role in the Nature Diversity Act of 2009. They shall provide information and guidance in the use of the decisions and ensure that evaluations are conducted at the right levels (Miljøverndepartementet, 2012:6). The County Governor has the primary responsibility to guide in regards to the duty of caution and follow up on potential breaches of this section of the Nature Diversity Act of 2009 (Miljøverndepartementet, 2012:12).

3.3.3 Local & regional management institutions

The municipalities can receive delegated authority in accordance with the Nature Diversity Act of 2009. They can reach decisions by the Planning- and building Act of 2008[63]. Part of the act gives rules regarding planning through municipality- and regulation plans. Measures decided through such plans cannot breach with existing laws, regulation or plans. The County Governor (fylkesmannen) can also decide to create regional action plans against alien species (Miljødirektoratet, n, u.d.). The County Governor should act as an advisor for the municipalities in order to coordinate efforts against alien species (Miljødirektoratet, n, u.d.).

3.4 Scientific institutions and committees

As seen in international agreements and national legislation decisions should be built upon scientific knowledge as long as it is considered reasonable under the circumstances. Among those guiding principle 5 of CBD COP 6 Decision VI/23 is about research and monitoring of invasive alien species. It is mentioned that "*In order to develop an adequate knowledge base to address the problem, it is important that States undertake research on and monitoring of invasive alien species, as appropriate.*" Research should include:

> "thorough identification of the invasive species and should document: (a) the history and ecology of invasion (origin, pathways and time-period); (b) the biological characteristics of the invasive alien

[62] Fylkesmann

[63] Plan- og bygningsloven mv. pbl (2008) Lov om planlegging og byggesaksbehandling (LOV-2008-06-27-71). Link: https://lovdata.no/dokument/NL/lov/2008-06-27-71?q=lov%20om%20planlegging

> species; and (c) the associated impacts at the ecosystem, species and genetic level and also social and economic impacts, and how they change over time." Principle 5 of CBD COP 6 Decision VI/23

Monitoring effort should be made in addition to research according to this principle. Monitoring includes both targeted and general survey, and involvement of different sectors and local communities.

Involvement of different stakeholders will further assist guiding principle 6 of CBD COP 6 Decision VI/23 which is about education and public awareness. Education and public awareness are important in order to inform about causes and gain support of measures taken against invasive alien species. The scientific institution and committee that is mentioned perform research to assist towards mitigating efforts but also lets the public access the same information that has been obtained.

3.4.1 The Norwegian biodiversity information centre (Artsdatabanken)

Measures implemented should be based on scientific gathered information. The Norwegian biodiversity information centre (NBIC) serves this purpose. The NBIC is a national source of information on species and ecosystems in Norway. The NBIC isn't a management agency but provide scientific information. It makes up-to-date information easily available for the government and the public. It was established through a parliamentary resolution and became operational in 2005 (n. Artsdatabanken, 2014). The NBIC is professionally independent with their own board. To serve their purpose they interact with the scientific community, policymakers, managers and data users (n. Artsdatabanken, 2014). One of their main tasks is to conduct risk assessment and provide The Alien Species List. How the risk assessments are conducted is further elaborated in a section dedicated to risk assessment as a management measure.

3.4.2 The Norwegian Scientific Committee for Food and Environment (VKM)

The Norwegian Scientific Committee for Food and Environment is a committee that also conducts risk assessments for the government. They assess risk on behalf of the Norwegian Food Security Agency and the Directorate of the Environment (VKM, u.d.). Their risk assessments are used to develop advise/or guidance, the regulative framework, permissions or input to governmental departments (VKM, u.d.). They do not give advice or opinions on how the risk assessments should be applied in policies. The committee are scientifically independent and interdisciplinary with about 100 members. The committee is appointed for a

four-year period by the ministry of Health and Care Services. This appointment is made in consultation other ministries as well[64](VKM. u.d).

The committee performs risk assessment commissioned by the Norwegian Food Security Agency and the Directorate of the Environment. For the Directorate of the Environment the area of which the committee is commissioned to perform risk assessment on are alien organisms and endangered species trade (CITES[65]), genetically modified organisms and microbiological products (VKM, u.d). The committee can also take initiative to conduct a risk assessment without being commissioned(VKM). They practise the same values as NBIC to be scientifically independent, interdisciplinary and to make their knowledge accessible for the public (VKM, u.d.).

This chapter covered the legal framework and management agencies that makes up the Norwegian management system in cases like the pink salmon. Following, the different measures applied by the management system is elaborated upon.

[64] Appointment is made after consultation with the ministry of Climate and Environment, the ministry of Trade, Industry and Fisheries and the ministry of Agriculture and Food

[65] CITES is also known as the Washington Convention of 1993. It has the aim of controlling and regulation trade of endangered fauna and flora. Link to Norwegian CITES regulation: https://lovdata.no/dokument/SF/forskrift/2018-06-15-889/KAPITTEL_4#%C2%A719

4 Management measures

This chapter examines how the Norwegian management agencies approaches alien species though implementation of measures. Measures and strategy of management should be encompassed in management plans (Cochrane & Garcia, 2009:11), therefor this chapter will firstly examine selected management plans. There is also given attention to international cooperation and risk assessment, as those are considered as important instruments of the Norwegian management system and pertaining to the case of the pink salmon.

4.1 Management plans

Unlike the Arctic king crab[66] and the Pacific oyster[67] there isn't any specific management plans in place for the pink salmon. There are other governmental plans that deals with biodiversity and alien invasive species that will be focused on. These has broader topic but still includes alien invasive species, such as the pink salmon, as a challenge for the Norwegian management system.

The topic of a white Paper from 2015-2016 was the diversity of Norwegian nature. Meld. St nr 14 (2005-2006) called *Natur for livet – Norsk handlingplan for naturmangfold* was published by the Norwegian Ministry of Climate and Environment[68]. In St. meld. nr 40 (2005-2006), nature is stated as a basis for our livelihoods, and a new white Paper was necessary to keep track of recent development which could threaten it (Klima- og miljødepartementet, 2015-2016:5). Through conservation and sustainable use, the Norwegian government want to secure its natural resources for present- and future use (Klima- og miljødepartementet, 2015-2016:5. Challenges like ocean acidification, pollution and foreign organisms are potential influencing forces that cause harmful changes in a complex ecosystem. The fear is that numerous habitats and species can start to decline and lead to a poorer ecosystem. The Aichi-goals[69] is mirrored in the three national goals and is mainly contingent on national action (ibid, 2015-2016:6). The three goals are about maintaining good conditions in ecosystems, conserve endangered nature and preserve a variety of natural areas. These natural areas should display the range of variation of Norwegian nature that is one "representative selection" (ibid,

[66] Management of the Red King Crab (2007) - white paper : https://www.regjeringen.no/contentassets/3a82509cc5694fa395654e4b01f3a0c5/no/pdfs/stm200620070040000dddpdfs.pdf

[67] The Norwegian action plan against Pacific oyster (2016): https://tema.miljodirektoratet.no/Documents/publikasjoner/M588/M588.pdf

[68] Klima- og miljødepartementet (2015-2016). *Natur for livet – Norsk handlingsplan for naturmangfold* (Meld. St. 14 - 2015–2016). Link: https://www.regjeringen.no/no/dokumenter/meld.-st.-14-20152016/id2468099/?ch=1

[69] The Aichi-goals are taken from the Convention on Biological Diversity (CBD)

2015-2016:6). It is stated in this white-Paper (Meld. st. nr 14 (2015-2016)) that there is a generational perspective in the management of Norwegian nature (ibid, 2015-2016:6). The management is summarized into main 7 main points; 1. A more accurate management of Norwegian nature, 2. A climate-adapted management of Norwegian nature, 3. Strengthening the competence of the municipalities regarding nature diversity, 4. Efforts for endangered nature, 5. Preserving a representative selection of Norwegian nature, 6. Knowledge-based management and 7. Tailored solutions for different ecosystems (ibid, 2015-2016:6).

Meld. st. nr 40 (2015-2016) on nature diversity is focused on the preservation and sustainable use of Norwegian nature. It is not ecosystem-specific or centred around specific challenges that faces the Norwegian management system, as the focal point is the entirety and the direction of Norwegian environmental policies. A proposal was created as a follow-up on this white Paper and is specifically targeting alien invasive species. The proposal consists of 28 suggestions of measures for an action plan to combat alien invasive species. 13 governmental agencies were involved in the proposal and was led by the Directorate of the Environment. Coordination between governmental bodies is stated as an important factor in combating alien invasive species and therefore joint efforts in this proposal is seen as an advantage (Miljødirektoratet, 2019). It is building on the priorities given by Cross-sectorial national strategy against alien invasive species[70] from 2007. Some of the proposal's suggestions is that early effort should be increased before alien species can establish, cost-benefit assessments are to be used so that the effort comes where the social benefits are greatest, and improve guidance and accessibility of knowledge (Miljødirektoratet, 2019). Improving guidance and accessibility of knowledge will be conducive towards better cooperation and coordination between governmental agencies, and for businesses and the general public to adhere to regulations.

Regional action plans against invasive alien species has also been published like that of the Action plan against harmful alien species in the county of Nord-Trøndelag (2016 – 2019)[71]. The Nature Diversity Act and regulation of foreign organisms commits anyone that can introduce and spread alien species to take the necessary considerations in order to avoid it. Different sectors like that of the Norwegian Public Roads Administration (NPRA) is also

[70] *Tverrsektoriell nasjonal strategi og tiltak mot fremmede skadelige arter* (2007) Link: https://www.regjeringen.no/no/dokumenter/t-1460-tverrsektoriell-nasjonal-strategi/id469655/

[71] *Handlingsplan mot fremmede skadelige arter i Nord-Trøndelag* (2016 – 2019). Link:https://www.fylkesmannen.no/globalassets/fm-trondelag/dokument-fmtl/miljo-og-klima/naturmangfold/fremmede-arter/handlingsplan---fremmedearter-2016-2019.pdf

required to take caution as to not introduce or spread alien species into Norwegian ecosystems.

Regional management plans are important when fauna and flora are dispersed across municipality- and county borders (Klima- og miljødepartmentet, 2015-2016:147). Involving the regional level of government into the Norwegian environment policies is in line with international- and national goals. The Planning and Building Act of 2008[72] is an important tool used by the municipalities to include the environmental policies on a local level. This Act gives the municipalities authority to shape the society and preserve the diversity of the nature within its area (ibid, 2015-2016:146). The preservation of diversity of ecosystems and other environmental goals can be included through a municipal plan. A municipal plan is a long-term sector-wide plan for the development and activities of the municipality. It consists of a community section with an action section and an area section (ibid, 2015-2016:147).

4.2 International cooperation

International cooperation is encouraged by several international agreements. This is often accomplished through Regional Management Organizations (RFMOs). As previously mentioned RFMO's are responsible for the management of stocks that are straddling- and highly migratory on the high sea through UNCLOS as well as UNFSA. The pink salmon is a migratory specie although there's some uncertainty connected to its route of migration into the ocean. In addition, the pink salmon has a higher deviation rate than other salmonids which increases their rate of expansion to, within and from Norway. This strongly reasons towards having strong efforts of cooperation and coordination on an international level, in addition to regional and national. A suitable RFMO to accomplish this through is the North Atlantic Salmon Conservation Organization (NASCO).

4.2.1 Measures adopted by the North Atlantic Salmon Conservation Organization (NASCO)

Under the convention of 1982 there was an agreement to establish an RFMO. This RFMO was established as North Atlantic Salmon Conservation Organization (NASCO) in 1984. NASCO follows a precautionary approach and therefor assesses potential threats to the wild Atlantic salmon, as for example climate change. Climate change is having a major impact on wild Atlantic salmon both in freshwater and in the sea. Rising temperature and water flow are direct causes of impact, while indirect causes of impact can be through ecosystem changes

[72] Plan- og bygningsloven – pbl (2008). Lov om planlegging og byggesaksbehandling (LOV-2008-06-27-71). Link: https://lovdata.no/dokument/NL/lov/2008-06-27-71?q=plan-%20og%20bygningsloven

such as food availability (NASCO, 2019:5). According to NASCO, the increasing temperature is expected to negatively affect freshwater systems in a higher degree than marine systems. This is due to the hydrology of the rivers (2019:5). There are numerable concerns on how climate change can impact the Atlantic salmon, and "Scientists are projecting that conditions for Atlantic salmon may deteriorate, both in freshwater and at sea due to climate change" (NASCO, 2019:5). The wild Atlantic salmon is vulnerable as their environment is changing at a rapid pace. Other stressors for the wild Atlantic salmon are amplified because of climate change (NASCO, 2019:7). An example of stressor are alien invasive species such as the pink salmon. NASCO needs to assess these challenges when managing the wild Atlantic salmon.

The pink salmon is considered by NASCO as a potential threat towards wild Atlantic salmon. A possible competition of resources between the pink salmon and the wild salmon population deems the pink salmon as a potential threat (NASCO, 2019:7). The pink salmon or other alien invasive species can also increase predation and introduce new pathogens on to the wild salmon population (NASCO, 2019:11). NASCO lists some potential management measures to reduce pink salmon. These management measures consist of hindering pink salmon from entering their river, catching them before spawning or destroying their spawning sites (NASCO, 2019:12). The drawback is that these measures demands significant efforts and can have negative impacts on fauna (NASCO,2019:12). There is also a necessity for co-ordination and co-operation of mitigation measures over a larger are to reduce the risk associated with pink salmon (NASCO,2019:12). Other alien invasive species can also have negative impact on wild Atlantic salmon is the rainbow trout (Oncorhynchus mykiss), minnow (Phoxinus phoxinus) and northern pike (Esox lucius), but there is a lack of knowledge (NASCO, 2019:11-12).

The parties to this RFMO are also countries that are experiencing an increase of pink salmon in some degree. The parties consist of Canada, Denmark (including Faraoe Islands & Greenland), EU, Norway, Russia, USA and France. Which are countries where pink salmon are occurring or naturally distributed. Iceland is a former member but is expected to return[73]. The numbers of observed and estimated numbers of pink salmon of member-States of NASCO from 2017 is shown in the table below.

[73] Withdrew in 2009 because of economic consideration after the financial crisis (source: http://www.nasco.int/about.html)

Country	Number of rivers where pink salmon are reported	Estimated number of fish			Total estimated number of pink salmon reported
		Caught in fisheries	Removed in targeted effort	Observed, but not removed	
Russia		270		125	395 (Based on a reported catch of 373.5 t, with an assumed mean weight per fish of 1.7 kg)
Norway	272	3925	2454	5428	11807
Finland		270		125	395 (numbers adjusted to allocate fish to Finland & Norway)
Sweden	6	80			80
Denmark	8	11			11
Iceland	35	66			66
Germany	2	2		1	3
France	2	1		1	2
UK (England & Wales)	8	208			208
UK (Scotland)	22	99	26	14	139
UK (N. Ireland)	2	1		1	2
Ireland	11	33			33
Greenland		2			2
Canada	2	3			3
USA					0
Total	369	224 698	2480	5570	232 750

Table 2: Reported or estimated numbers of pink salmon in different countries with sea borders to the North Atlantic 2017. Demonstrating that several countries in Europe are experiencing a rise in pink salmon, but Norway beside Russia have a higher occurrence of observed, caught or removed pink salmon in 2017. This table was derived from a revised report done by ICES Advisory Council in response to term of reference posed by NASCO (2018:11)[74].

From the table it can be noted that two countries have attempted targeted remove. Scotland and Norway had targeted removal of pink salmon, but there were still more caught in fisheries than through these targeted efforts. The numbers also show a large difference of abundance but also a wide distribution of pink salmon in the northern-Atlantic.

[74] NASCO (2018). *Revised Report of the ICES Advisory Committee* (CNL(18)08rev). Retrieved from http://www.nasco.int/pdf/2018%20papers/CNL_18_08rev_Report%20of%20the%20ICES%20Advisory%20Committee%20(ACOM).pdf

Alien species are an additional stressor for the wild salmon population that is amplified by climate change. At this stage NASCO is monitoring the situation of the pink salmon and other alien species that can have a potential negative impact on the wild Atlantic salmon population. At this point there are too little knowledge on the impact of pink salmon on the wild Atlantic salmon population, but as stated "knowledge of the ecological consequences or impacts of biological invasions is often gained after the introduced alien species have become well established" (NASCO, 2019:12). At this point the damage is often done, so better surveillance and identification is advised to allow for early mitigation efforts (NASCO, 2019:12). Mitigation effort should also be coordinated over larger areas to have a long-term effect, so mitigation efforts might require regional and international collaboration and co-ordination with an aim of reducing pink salmon (NASCO, 2019:12). Collaboration between relevant agencies, managers and conservation organisation is advised to ensure preferable conditions for the wild salmon population and mitigate negative impacts from invasive species (NASCO, 2019:12)

4.3 Risk assessments

In the Nature Diversity Act of 2009 there's a demand for a knowledge as a base for decision-making. This stated in section 8 of the act. Scientific knowledge is defined as knowledge gathered by scientific methods. It should also uphold the scientific standards of objectivity and replicability (Miljøverndepartementet, 2012:31). Scientific knowledge produced and used when deciding upon regulation which can affect the diversity of the ecosystem is often risk assessments, diversity mapping or other reports on diversity. Scientific knowledge that can be used in policymaking is not usually produced by the management institution themselves. Risk assessment can be produced by independent scientific institutions. Risk assessments, diversity mapping or other rapport produced by scientific institutions can also be commissioned by management agencies.

Textbox 3. The need for knowledge-based decision making

The Nature Diversity Act of 2009, Section 8, first paragraph:

"Official decisions that affect biological, geological and landscape diversity shall, as far as is reasonable, be based on scientific knowledge of the population status of species, the range and ecological status of habitat types, and the impacts of environmental pressures. The knowledge required shall be in reasonable proportion to the nature of the case and the risk of damage to biological, geological and landscape diversity."

4.3.1 NBIC assessments and recommendations

The risk assessments are essential for the Norwegian management agencies in order to develop a comprehensive management plan for alien species. The risk assessments are done

by multiple expert-committees. They use a quantitative method, which separates Norway from many other countries doing alien species assessments (Artsdatabanken, 2018a). The method was developed in Norway and is called GEIAA (Generic Ecological Impact Assessment of Alien Species). It has scored high on repeatability of results. Ability to replicate results are one of the advantages of using this Norwegian method of assessing alien species. Not all alien species are assessed because of definition and delimitations given in the publication *Guidelines for the Generic Ecological Impact Assessment of Alien Species* (Artsdatabanken, 2018a). The species that are assessed is tested against nine quantitative criteria's which consist of two subcategories. The two subcategories are ecological effect (on native fauna and flora) and the second is invasion rate. The NBIC is a neutral party which assesses alien species based only on biological criteria. As it is based on biological criteria it doesn't consider socioeconomic factors in the risk assessment. Experts are encouraged to provide some answers to socioeconomic effects as it is a part of the European minimum standard when assessing alien species, but it doesn't need to affect the result of their evaluation (Artsdatabanken, 2018).

Textbox 4. The nine criteria's (A-I) of the Norwegian risk assessment:

Criteria A-C assesses the potential for invasion:

Criteria A is the stocks ability to survive (measured in the median survival rate of the stock.

Criteria B is the estimation of expansion rate in meters pr. year.

Criteria C is the percentage of habitat that can be colonized by the species.

Criteria D-I pertains to potential ecological effects:

Criteria D is about the degree of negative interaction with endangered- or key species.

Criteria E is about degree of interaction with native/autochthonous species.

Criteria F is about the species effect on endangered- or rare habitats while **criteria G** is about effects on habitat in general.

Criteria H is about the likelihood of transference of genetic material from foreign species to native-, endangered or key species.

Criteria I is used to estimate the likelihood that alien species can transmit parasites or pathogenic organisms to native species and endangered species / key species.

(Artsdatabanken, 2018b)

The risk category of an alien species gets decided based on the results from the nine criterions. The results can be placed into a two-dimensional matrix. On the x-axis of the matrix shows the potential risk for invasion and the y-axis the ecological effects (artsdatabanken, 2018a). The pink salmon has the criteria 4B in risk for future invasion and 2E for ecological impact in Norway. These criteria land the pink salmon in the category high risk in the risk assessment from 2018.

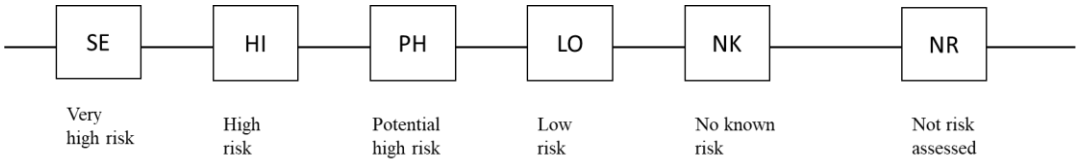

Figure 4 Display of categories that alien species are placed in based on the criteria of the GEIAA-test done by the NBIC. (Artsdatabanken, 2018)

The results from assessments conducted each year is published on The Alien Species List. The Alien Species List was previously known as the blacklist.

4.3.2 The Norwegian Scientific Committee for Food and Environment's assessments and recommendation

The Norwegian Scientific Committee for Food and Environment[75] was commissioned by the Directorate of the Environment and The Norwegian Food Safety Authority to conduct a risk assessment on the pink salmon. This risk assessment was published the 15th of January 2020. The request was to report on six terms of reference pertaining to pink salmon in Norway. The terms of reference involved identifying and assessing potential hazards associated with the increase of abundance of pink salmon, potential and likelihood of consequences associated with expansion and suitable mitigating measure (VKM et al., 2020:24). The timeframe of the risk assessment was the adverse effect on biodiversity within the next fifty years or five generations for species with a generation time of more than 10 years (VKM et al, 2020:24) This timeframe was given in accordance with the time perspective of the risk assessment by the NBIC (VKM et al, 2020:24)

The methodology used in this risk assessment is of a semi-quantitative approach. The method was based on comprehensive literature research, gathering of information with other scientist from different nations and from different stakeholders such as fisheries associations (VKM et al, 2020:17). The result of the report can be put into a matrix. The scale ranked high, medium and low. It was measured based on magnitude of potential environmental impact and overall likelihood of impact. The results that emerged were based on the judgement of the project-group experts (VKM et al., 2020:42).

The results of this risk assessment concluded with that the environmental risk was closely linked with the abundance of pink salmon. With a higher abundance there is a higher chance of serious repercussions on the biodiversity of the ecosystem (VKM et al, 2020:12). The reason behind the recent rise of abundance in 2017 and 2019 is important to ascertain in order to predict future development. There was found a correlation in this report between abundant return of pink salmon with rising ocean temperature in the Northern Atlantic and Barents Sea (VKM et al, 2020:14). This can indicate that effects from climate change might continue to benefit the pink salmon. This correlation was found by sing data of sea-surface temperature from 1900 to 2019; " we find that the number of pink salmon returning can be relatively well predicted (adjusted $R2 > 0.5$ for a positive relationship) by sea-surface temperature in the area south of Svalbard and of the cohort size two years previously for all three data sets considered" (VKM, 2020:14). It is also remarked in the report that rapid rate of which climate

[75] Vitenskapskomiteen for mat og miljø (VKM)

change transpires makes its effects unpredictable, but there is a likelihood it will be beneficial for the establishment of pink salmon population in Arctic rivers (VKM,2020:14). It also seems that the pink salmon can adapt over a few generation (VKM,2020:14). The combination of favourable conditions and the adaptability capacity of the pink salmon might be the secret behind its recent and possible future success.

Some of the risk is that a higher abundance of reproducing pink salmon might lead a higher return rate. As a result, juveniles might negatively affect invertebrate fauna as this is a food source for pink salmon (VKM et al., 2020:12). The report from VKM also states that this is more likely in a long river than a short (2020:12). Other risk is between the rise of pink salmon and pathogens. 11 pathogens have been assessed were 4 of them can infect pink salmon. None of them scored high level of confidence with associated risks. It was either low or moderate confidence of risk associated with pink salmon (VKM et al, 2020:13). These results may be affected with an increase of of abundance.

A concern is how a rise in abundance of pink salmon might affect the social-economic dimension. If the pink salmon rises to dominate rivers there will be negative impact on economic value of salmon-angling. Catches of smaller pink salmon that is not fit for consumption (after entering the river) will decrease value derived from salmon-angling compared to that of Atlantic Salmon (VKM, 2020:13). It may also occur interaction with native salmonid as a result of high densities of pink salmon. The interaction could through competition for space or food (VKM et al, 2020:13).

This was some of possible negative impact that can arise due to an abundant pink salmon population, but some has a higher risk of occurring based on this report. The report also stated that efforts from 2019 and 2020 had been proven efficient of reducing or eliminating the risk associated with the pink salmon. So, it might be feasible under the right circumstance to either reduce or eliminate the threat of pink salmon (in individual, or at least in smaller rivers) (VKM et al, 2020:15). It is dependent on concerted action on regional, national and international level (VKM et al, 2020:15).

5 Discussion and conclusion

The aim of this thesis has been to explore whether the pink salmon is in Norway to stay based on properties of the management system and the unique biological characteristics of the pink salmon. These issues are identified and assessed through acquiring an overview of the management system and the pink salmon itself. The combination of allocation of responsibility and authority among the management agencies, legal framework, implementation of measures and the biology of the pink salmon gives insight into if this is a challenge that the Norwegian management system is adequate to handle. Due to all the different factors that can determine the outcome, a multidisciplinary approach was applied.

5.1 Is the pink salmon a problem that need to be or can be solved?

The first research question asks whether the pink salmon is a problem that needs to be or can be solved? When trying to assess whether the pink salmon is a problem that really needs solving then the theories connected to traditional conservationism and opponents often termed as 'denialist', can offer some insights.

Traditional ecological conservationist believes that there are biological differences between native and non-native that might disrupt and damage the structure and function of ecosystems after invasion (Sagoff, 2019:10). There can also be a lack of natural predators which can lead to dominance over native species. Alien species are often referred to as "the second greatest threat after habitat destruction to native fauna and flora" (Sagoff, 2019:2). Alien species has quantifiable risks that can negatively affect a complex ecosystem. Even those alien species that are non-predatory is to be considered a threat (Sagoff, 2019:2).

According to opponents of traditional ecological conservationism the means of arrival of non-native species holds too much significance. There is criticism against the ontological divide as human see themselves as apart from nature as a separate entity. Any alteration upon nature which is caused by humans is an unnatural process. There is also criticism that the term 'alien species' installs a level of fear that may not be rational if they do not possess the ability to negatively impact the environment. The fear of these foreigners is rooted in their potential to alter our status quo and with potential impacts that are hard to predict. Pearce advocates rather for seeing the establishment of alien species as 'signs of nature's resilience' that is "expressed in the strength and colonizing abilities of alien species"(Pearce, 2015:2). Resilience refers to nature's capability of evolving and that it does not go backwards. Evolving means changing, but this doesn't necessarily mean that that changes will lead to enhancement of the current

state of the ecosystem. What constitutes as an enhancement can be dependent on goals set by policies, which is often social, economic and ecological sustainability of the ecosystem.

Alien species that establish and then becomes invasive can either be beneficial or damaging (or neither) to the environment and society. It can in some cases have no effect or be a blessing. Alien species can become an additional economic resource to rely upon or enrich the ecosystem. In other cases, alien species becomes horror stories as they are a cause of damage to the biodiversity and ecological processes of the ecosystem. These horror stories are acknowledged by the opponents of traditional conservationism like Pearce. Although acknowledging it, Pearce argues that there is put too much emphasis on horror stories and alien species are turned into scapegoats like in the example of the Nile perch in Lake Victoria[76]. An alternate explanation opposed to alien species as a cause of extinction is that in many cases they are rather opportunist that takes advantage of the havoc that humans create in their wake (Pearce, 2015:6). These misplaced notions of alien species and how nature actually work leads to conservation efforts of ecological cleansing that often fail (Pearce, 2015:6). Pearce argues that not only our idea of nature but also conservationism needs a reboot (Pearce, 2015:7). Considering Pearce's arguments, the pink salmon might just be a winner of evolution, although human assistance is a key factor in their recent success. The pink salmon can be taking advantage of climate change where other species are not capable.

One of the main concerns with pink salmon is its adverse effects on native salmonid populations, specifically the Atlantic Salmon. The Atlantic salmon is already under external pressures is vulnerable, and the fear is that pink salmon will be another stressor that is amplified by climate change (NASCO, 2019:7). The latest report by Norwegian committee of Food and Environment (VKM) has concluded that a correlation exists between abundant return of pink salmon with ocean surface temperatures in the North Atlantic Ocean and Barents Sea (VKM et al., 2020:14). Pink salmon also shows an ability to adapt to new conditions over few generations (VKM et al., 2020:14). So, although the pink salmon is generally a cold-water fish their ability to adapt to environmental conditions might benefit them as ocean temperatures continues to rise (VKM et al, 2020:14). The Atlantic salmon and the pink salmon can have better capabilities of adaption but potential weaker species has the

[76] The Nile perch was introduced into Lake Victoria by British colonialists in the 1950s. The Nile perch are blamed for the for extermination of hundreds of cichlid species. Later, others have pointed to that the real cause may not be the Nile Perch but rather pollution which weakened them into easy prey for the Nile perch. This would make the Nile perch a specie that took advantage of an environmental crisis but not the main cause (Pearce, 2016:50-51)

benefit of being a native. This is seen from the perspective of the critics of the ontological divide, which argues that certain perceptions of nature, alien species and conservationism might be misguided. There are other sides of the case that needs to be considered to ascertain whether pink salmon is really a problem that need to be or can be solved. This has served the purpose of exploring whether some of the values of current policies and consequently the approach is misguided. Other arguments need to be considered pertaining to alien species is the social, economic and biological sustainability of the ecosystem.

The dispute between traditional conservationism and their opponents is on-going. While critique of traditional ecological conservationism is for example that the estimates of costs by Pimentel et al. are not backed by empirical evidence (Sagoff, 2019:2). While conservationist argues that the scientific facts remains undisputed, as those who critique only argues on "the influence of values on the application and interpretation" (Sagoff, 2019:2) Considering opinions of Chew et.al there should rather be evidence that is based on a species biology and not on its history of arrival (2011:36).

Risk assessments conducted and used by the Norwegian government takes into account identification and documentation of a species history, but also includes assessment on its invasion rate and ecological impact with a 50-year perspective. The risk assessment considers how an alien species may affect the environment in the future. The latest rapport by the Norwegian Committee for Food and Environment[77] reached a conclusion that the of negative impact on the ecosystem is dependent on the numbers of pink salmon. If the abundance further increases, there is an increased risk that it will have adverse effect on the ecosystem (VKM, 2020:12). A high abundance of spawning pink salmon can have substantial impact on native salmonids, as well as on water quality and biodiversity (VKM, 2020:14). Higher abundance is also made more likely based on the correlation of abundant return and rise of ocean temperature in the norther Atlantic and Barent Sea (VKM, 2020:14). The response from the report from the Norwegian Committee for Food and Environment on how an higher abundance of spawning pink salmon might become a threat against biodiversity and river systems was that "thousands of spawners will possibly produce millions of offspring that may impact small invertebrates and crustaceans negatively and compete with native salmonids for food and space after hatching" (VKM, 2020:12 . This might affect the food web of the marine

[77]Link to report: https://vkm.no/risikovurderinger/allevurderinger/risikovurderingavpukkellaks.4.303041af169501216097605d.html

ecosystem. However, the pink salmon might also serve as an additional source of food for birds. There is also an increased risk of spread of pathogens into wild fish populations and aquaculture caused by an abundant return of pink salmon (VKM, 2020:13-14). The report mentions several possible benefits and negative impacts. It was concluded that adverse effects on the ecosystem increases with a higher abundance while a low abundance would be inconsequential (VKM, 2020:14).

There is a level of uncertainty as with any risk assessment. To determine with certainty the outcome of a situation that is dependent on so many factors is not possible. If the risk is present and there is a lack of sound scientific advice, then the precautionary approach is applicable. The precautionary approach states that if there is a risk of harmful or irreversible damage, an absence of sound scientific information should not be used as a reason for failing to take appropriate action[78]. By following a precautionary approach, it is reasonable to consider the pink salmon as a problem that needs to be solved if the abundance continues to increase. The pink salmon has a potential to become a horror story, although evidence can point to that this is a symptom of a disease and not the cause. The pink salmon might be taking advantage of climate change where other species are not able to. Those vulnerable native species might continue to deteriorate because of other effects of climate change, as climate change amplifies other stressors in addition to alien species. A predicament might be enhanced as ocean temperatures continue to rise. The question is whether we should place our bet on a species that can adapt or focus on preventing the pink salmon from putting additional pressures on native species. If the pink salmon was a natural resource from an economical perspective the course of action might be containment like in the case of the Arctic king crab. Containment is also harder with a migratory species with high deviation rate like that of the pink salmon.

According to the report from the Norwegian Scientific Committee for Food and Environment, targeted fishing efforts to decrease or eliminate the threat of pink salmon has been shown as effective in this case:

> "Experience from 2017 and 2019 shows that such efforts are effective and can decrease or even eliminate the threat of pink salmon to native salmonids and biodiversity in individual rivers, at least in smaller rivers. In order to reduce the number of pink salmon and the recurring returns of pink salmon spawners to Norwegian coastal waters and rivers in general, however, concerted action on a regional, national and international level is required" (VKM,2020:15).

[78] Principle 15 of the Rio Declaration on Environment and Development. Link: https://www.cbd.int/marine/precautionary.shtml

If measures are reasonable and feasible the management agencies are obligated through international agreements and national legislation to either eradicate, control or contain this alien invasive species.

The VKM report from 2020 concluded that impacts are more likely to increase with a higher abundance, and the abundance is more likely to increase with a higher ocean temperature. If the abundance continues to increase, further mitigation measures can become more urgent and necessary. The exact impacts are hard to predict, and the ecosystem can be affected in several ways. I agree with Pearce that nature will evolve as nature always does, but there is no guarantee that there will be social, economic or ecological benefits derived from this change. The experience from 2017 and 2019 mentioned above states that the targeted efforts from these pink salmon years were effective to the point that these efforts can either decrease or eliminate the threat of the pink salmon to native salmonids and some rivers (VKM, 2020:15). The stipulation is that concerted action is required on a regional, national and international level (VKM, 2020:15). This might be a horror story or not, but according to the ecosystem-based and precautionary approach which Norway follow there is a need to act based on risk assessments that has addressed the risks associated with a continued rise of abundance. The pink salmon can be just one of the many symptoms of climate change, but it might exacerbate the situation. This is based on risk assessments of the pink salmon, and not based on its history of arrival as an alien species that turned into an alien invasive species.

So, the pink salmon is a challenge that needs to be solved if the abundance of returning spawners continue to increase and expand across Norway. This is made more likely by favourable conditions of ocean temperature rise in the northern Atlantic and the Barents Sea. Without a further increase of abundance its impact may be inconsequential. It is also challenge that might not be completely reversed but can be managed under the right efforts and circumstances. Cooperation and co-ordination on all levels of management is a stipulation for the success of managing pink salmon.

5.2 What measures are applied by the Norwegian government to address the issues caused by alien species?

The second research question is constructed to explore how the Norwegian government operates regarding addressing the issues caused by alien species. The research question is: What measures are applied by the Norwegian government to address the issues caused by alien species? If challenges like the pink salmon needs to be solved or can be solved, then

how the management system operates will be a contributing factor towards a potential success or failure.

Norway follows the guiding principles put forward by the Sixth Meeting of the Conference of the Parties to the CBD, that of the three-stage hierarchical approach and precautionary approach. These guiding principles regards the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species. The precautionary approach is in guiding principle I of CBD COP 6 decision VI/23, *"Given the unpredictability of the pathways and impacts on biological diversity of invasive alien species, efforts to identify and prevent unintentional introductions as well as decisions concerning intentional introductions should be based on the precautionary approach,…"*. These guiding principles has a purpose of giving guidance to governments for the implementation of article 8 (h) of the CBD. Article 8 (h) of the CBD comes into effect in cases where alien species "*threaten* ecosystems, habitats or species". The phrasing indicates that it is not limited to species that causes negative impact but also those that can have a 'potential' negative impact on ecosystem, habitats or species. The three-stage hierarchical approach can therefor come into effect on an early stage if there is a potential threat by alien species. Therefore, assessing risk and obtaining knowledge in order to determine if an alien species is a potential threat is an important step of this management approach. Guiding principle I of the CBD COP 6 decision VI/23 also states that "... *Lack of scientific certainty about the various implications of an invasion should not be used as a reason for postponing or failing to take appropriate eradication, containment and control measures."*. As stated by NASCO the ecological impacts of alien species are often not known before after establishment and after this point the damage is often irremediable (2019:12). So, waiting for the risk to be confirmed can led to impacts that could be avoided or minimized by early mitigation efforts.

Norway follows the tree-stage hierarchical process as a guiding principle for implementation of article 8 (h) of the CBD. This three-stage hierarchical process consist of eradication, containment and long-term control as responses if prevention has failed and an alien species is a threat to ecosystems, habitats or species. Prevention is preferred out of economic and ecological considerations. If prevention has failed and an invasive alien species has established, then rapid and early detection is crucial. The preferred response is eradication. If eradication is not feasible or there is a lack of resources then containment and long-term control measures should be implemented, according to guiding principle II of CBD COP decision VI/23.

In 2015-2016 the Norwegian government published *Natur for livet – Norsk handlingplan for naturmangfold* (Meld. st. nr.14 (2015-2016*)* [79]. This white Paper describes the government's policies for maintaining the Norwegian biodiversity and contributions towards reaching national and international goals. It also describes biodiversity challenges facing the environment such as the spread of foreign organisms. The white Paper states that central actors in successful management of Norwegian nature is the municipalities, and therefor suggest measures to increase their knowledge concerning diversity. As a follow up to this white Paper, 28 measures have been proposed for a new national action plan against alien species. These proposed measures have also been based on a national action plan called *Tverrsektoriell nasjonal strategi og tiltak mot fremmede skadelige arter*[80] from 2007. One of the proposed measures is increasing risk assessment for foreign species that is showing signs of establishing. This type of approach to management can be defined as risk management.

Risk can be defined as "a chance of adverse effects from deviations from expectations" (Sethi, 2010:343). By this definition introduced alien species can easily be placed into the risk category, and the pink salmon along with it. Risk management was also further defined as "a loose term for the general process of identifying, characterizing and reacting to risk" (Sethi,2010:343). Risk assessment is an important measure in Norwegian management system as there is an aim for the policies to be knowledge-based and having a precautionary approach. These risk assessments are a part of the first stage of risk management. These risk assessments are conducted by scientific institutions like the NBIC and the Norwegian committee for Food and Environment (VKM) described in chapter 3.4. The first stage of risk management is identifying and characterizing risks, which is the main task of a risk assessment. The methods applied in risk assessments vary, as seen by comparing the methods of NBIC and the Norwegian Committee for Food and Environment. Both assessments have a fifty-year time frame for assessment of possible impacts. The results of the risk assessment are considered in the decision-making process by the Norwegian government. The NBIC and the Norwegian committee for Food and Environment does not advise the government regarding their policy but only provide information. The risk assessment may determine the second phase of risk management, which is treatment. As management of fishery is a complex matter where social, ecological and economic aspects need to be considered can lead to an

[79] Klima- og miljødepartementet (2015-2016). *Natur for livet – Norsk handlingsplan for naturmangfold* (Meld. St. 14 - 2015–2016). Link: https://www.regjeringen.no/no/dokumenter/meld.-st.-14-20152016/id2468099/?ch=1

[80] Translated title: cross-sectoral national strategy and measures on invasive alien species

outcome which is not solely based on scientific knowledge. So, whether control, containment or eradication measures are applied can be a result of compromises between different interests. Nature in itself is also hard to predict, so "risk assessments methods provide means to address increasing complexity for successful fisheries management by systematically identifying and coping with risk" (Sethi,2010:341).

Norway can be said to have to a risk management system for alien species, due to having a precautionary approach. In a risk management system, there is a higher focus on possible adverse impacts rather than benefits that can be derived from it. Risk is as a result measured at a steeper angle than benefits. The pragmatic goal of risk management is minimization of the effects of unpredictable variability (Sethi, 2010:343). By including uncertainty and risk into the decision-making process there might be a better chance for the management system to either prepare for or prevent an undesired outcome. Inclusion of uncertainty and risk will increase the chance for the management system achieving a desired outcome (that allows for present and future ocean-use). Achieving a desired outcome in ocean-management is a hard and complex task. This is partly due to natures unpredictability caused by innumerable influencing factors which forces nature to alter. Nature is never constant, but some changes are more damaging due to its rate and size of impact. Changes in the ocean caused by climate change is a possible explanation for the recent abundance of pink salmon, and other changes in the ecosystem will also likely transpire due to climate change. So, achieving a desired outcome demonstrated through the policy objectives will be an increasingly complex and hard task for the management system. Climate change will keep forcing species to adapt or deteriorate by the natural process of selection. Humans can intervene but this will require an increasing amount of resources and knowledge.

Cooperation regarding combating alien species between two or more countries is also encouraged through the CBD COP 6 Decision V/23. This is not binding, which is also the case with the other guiding principle, but rather encouraged depending on the situation. These efforts may include A) programmes to share information, B) Multilateral or bilateral agreements to regulate trade in certain alien species with an focus on particularly damaging invasive species, C) Support capacity-building programmes in other States that has little expertise or resources and D) Cooperative research effort.

In a risk management system, an important measure is the risk assessments. This defines the first step and determine the treatment measures. Early detection and rapid action are essential in combating alien species, and Norway has a system for identification and monitoring

species that shows signs of establishing. If risk assessments consider an alien species as having a low ecological impact for the next fifty years, then further treatment measures would not be considered as cost-effective. With increasing ecological impact in a risk assessment further measures of eradication, containment and control will be settled upon. It only extends to measures that is considered feasible and resources are available. This can be done through management plans that are national- or regional. These management plans and risk assessments is made easily public- and easily available. This raises awareness and knowledge that is shared with the civic-society, organization and States. RFMOs like NASCO can gather information from Norway and other countries. Beside sharing knowledge and information, in the case of pink salmon there is currently only domestic efforts, but the situation might change in the future to the point where increased international cooperation between affected countries might be necessary to minimize or eliminate the threat.

The Norwegian system for managing foreign species can be summarized in the two stages of risk management. The first stage is risk assessment where species are identified and monitored. Risk assessments are an integral part of the Norwegian management system because depending on the results from the risk assessments the next stage is treatment. The result from the risk assessment can determine if treatment is measures of eradication, control or containment. The treatment stage can also not be considered as reasonable or feasible, and further mitigation are not explored. In these cases, surveillance and monitoring would continue to assess whether there are further development of expansion and ecological impact that calls for mitigation efforts. The measures applied by the Norwegian management system for alien species can be divided into the two stages of risk management: risk assessment and treatment.

5.3 Is the Norwegian management system adequate through the current legislation to handle the case of the pink salmon?

A management system that has a fast response time and ability to implement the right measures is essential in order to reach environmental goals. The Norwegian management system approach is dependent on its legislative framework which entails international agreements and national legislation. The last research question is if the Norwegian management system is adequate through the current legislation to handle the case of the pink salmon? The Norwegian legislation reflects the policy agenda and design, allocation of resources and responsibilities that may provide answers to the adequacy of the Norwegian management system. The Norwegian management system is here seen through Winters

integrated framework for implementation studies[81]. Winter puts implementation theory into a socio-economic context.

The Norwegian legislation provide information about the policy formulation process. "Policy formulation covers the political process of agenda setting, finding acceptable way of addressing identified problems, and in the final decision-making leading to the adoption of a policy" (Sander,2018:486). The Nature Diversity Act contains the general laws in matters that regards the diversity of Norwegian nature and ecosystems. It states its purpose in chapter I section I of the Act: "*... protect biological, geological and landscape diversity and ecological processes through conservation and sustainable use, and in such a way that the environment provides a basis for human activity, culture, health and well-being, now and in the future, including a basis for Sami culture*." This is to be done through a precautionary- and ecosystem-based approach. The intent of this Act is to ensure that the environment can continue to function as a way of providing livelihood, as food security and safeguards the traditional values for inhabitants or distinct cultural groups in Norway. This demonstrates a symbolic policy of safeguarding the resources with the purpose of maintaining the diversity and ecological processes, while also considering cultural aspects. The Nature Diversity Act serves the purpose of maintaining the diversity and ecological processes both for present- and future use through conservation and sustainable use. This act has a generational perspective. With these values the government demonstrate good intentions by including social, economic and ecological aspects into their policies, but there are inherent conflicts between these.

These values affect the view of non-native species that shows signs of establishment and expansion in Norway, also known as alien invasive species. The objective for habitats and ecosystem of the Act is to "*maintain the diversity of habitat types within their natural range and the species diversity and ecological processes that are characteristic of each habitat type. The objective is also to maintain ecosystem structure, functioning and productivity to the extent this is considered to be reasonable.*" (section 4 of the Nature Diversity Act of 2009). This pertains maintaining habitat and belonging species that are within their natural-range and not those that can be an agent of change. This set an agenda for the Norwegian environmental policies regarding diversity. As with article 9 of the CBD it only extends to what is considered reasonable. Although objectives traditionally should be made clear in regards to implementation, in cases where policy-makers want to achieve more than one thing (as they

[81] Figure of Winters integrated framework for implementation studies can be seen in *Implementation of ecosystem-based managemen*t by Sander (2018:36).

often do) ambiguity is often used to reduce conflicts (Sander: 2018:487) Conflicts often arises between the social, economic and ecological dimensions as to what can be considered as reasonable.

Policy design usually involves description of a problem, a desired direction and a set of measures (Sander, 2018:487). These measures contain policy instruments, combined with allocation of responsibility and resources for allocation (Sander, 2018:487). A national action plan for combating alien invasive species is currently being developed, so additional measures against alien species is still being discussed. Although based on the proposal for additional measures, it appears that increasing existing efforts is the main focus (miljødirektoratet, 2019). Increase of knowledge and accessibility, risk assessments, management plans, cooperation and coordination are all part of the suggested measures. To be more specific these suggestions involved closer cooperation between authorities and customs, regional management plans, information and guidance to reduce risk of releasing foreign organism, increase the knowledge of impacts, conduct more risk assessment of species that shows signs of establishing. These measures might be considered reasonable put into context of climate change that increases the risk of species and can weaken native species that has low adaptability capacity.

Norway has a top-down system of public administration where there is focus on cooperation between different governmental bodies. Delegation of power is important in the management of foreign species which makes it possible to have authority present also on the lowest level of government. The highest authority belongs to the government, but delegation of authority to other governmental agencies is an important factor in how the Norwegian environmental protection laws operates. The delegation of authority requires coordination and cooperation between several governmental bodies in order to reach environmental goals. The presence of management authority on national, regional and local levels should ensure higher compliance with the regulations. Information and guidance are important in order to achieve compliance therefor the directorate and the county governor has important roles as management institutions. These governmental agencies have an advisory role with presence in large part of the country. They also have the authority to sanction violation of laws and regulations in accordance with the Nature Diversity Act of 2009. The ministry safeguards the entirety of the environmental policy of the Government. All the other managing institutions is subject to them as they are the highest administrative authority. As the municipalities manage their own areas it is required by them to incorporate environmental goals into their management plans.

By these management institutions the environmental goals are tried implemented on national-, regional and local levels. All the levels of management authorities have an important part in the national effort towards reaching goals set by national legislation and international agreements.

Whether all this contributes towards a desired outcome is hard to assess, seen in relation to managing alien species to the extent that the diversity of ecosystem and the ecological processes is protected. Each case is different as their invasion rate and ecological impacts varies. Their overall impact determines if and what kind of regulatory measures that are put in place. Assessments are done by scientific institutions, and further evaluated by governmental agencies to determine which regulation should be put in place. In the case of the king crab there is focus on containment which allows for economic advantages, although here there are also conflicts due to the impacts that the king crab causes in its area of establishment. There are also other concerns in this case, but the management system appears successful in many instances. Risk assessment done on the pink salmon point too that further measures need to be implemented if abundance continue to rise. This requires efforts on local, regional, national and international level.

In section 1 of article 56 of UNCLOS, sovereign rights are given to coastal State in their Exclusive Economic Zone. This allows Norway to have sovereign rights and jurisdiction within the breadth of the EEZ. Other provisions of UNCLOS as well as UNFSA provide the authority to manage stocks that migrates or straddles beyond and/or across the borders of EEZs, such as the pink salmon and the Atlantic salmon do. Article 66 of UNCLOS is pertinent for managing anadromous stocks within and outside of a State's EEZ. Section 1 of article 66 of UNCLOS, asserts the primary interest and responsibility to straddling- or migratory anadromous stocks belongs to the State of Origin. Through article 66 there is also commitment of collaboration between State of Origin and other States that are fishing on these stocks. Section 4 of article 66 of UNCLOS commits States to collaborate on managing and conserving stocks that are on the high Sea and crosses the borders of their EEZs. Section 5 of article 66 of UNCLOS gives the foundation for establishing RFMOs in cases where it is considered appropriate. Section 5 of article 66 of UNCLOS states that "*The State of origin of anadromous stocks and other States fishing these stocks shall make arrangements for the implementation of the provisions of this article, where appropriate, through regional organizations*". This has facilitated the establishment and operation of NASCO and allows for application of the precautionary approach towards the Atlantic salmon population also on the

high Sea. Such arrangement can allow for co-operation and co-ordination over a larger area, which is needed in cases with anadromous species such as the pink salmon. NASCO has the objective to "promote conservation, restoration, enhance and rationally manage wild salmon through international co-operation taking account of the best available scientific information" (NASCO, u.d.). These objectives can involve eliminating threats such as the pink salmon if the abundance continues to increase. Based on the VKM report from 2020 an increased abundance can have negative impact on the native salmonid population. Therefore, through the precautionary approach, it can be within the purview of NASCO to minimize the risk associated with the pink salmon.

There is coverage through both national legislation and international agreement to manage the pink salmon. The threat of impact derived from the pink salmon increases with a higher amount of returning spawners. There is room on both the international-, national and regional level to implement measures to either eradicate, reduce or control the pink salmon. There need to be co-operation and co-ordination across borders, and this is easier to accomplish by arrangements such as RFMOs.

5.4 Conclusion

The pink salmon is a challenge for the Norwegian management system that will become more urgent to solve if the numbers of returning spawners continues to increase. The precautionary approach can be applied if there is a potential threat, and as stated by NASCO "knowledge of the ecological consequences or impacts of biological invasions is often gained after the introduced alien species have become well established". After this point the damage is often done and hard to reverse. The VKM report from 2020 on the pink salmon concluded that the risk of negative impacts increases with the abundance of returning spawners. It also found a correlation between the increase of abundance and higher ocean temperature. There is a likely chance that without further mitigation efforts the pink salmon will continue to roam around and thrive in the Northern Atlantic region.

Confirmed treatment will be the next stage of risk management after risk has been identified and characterized. Efforts from 2017 and 2019 has been shown as effective to the degree of decrease or even elimination of the threat by pink salmon to native salmonids and biodiversity in certain rivers (VKM,2020:14). There is a chance of decreasing or even eliminating the threat in certain areas, but it requires "concerted action on a regional, national and international level" (VKM,2020:14). As concerted action is required over a larger area, within and across EEZs. UNFSA can allow that the precautionary approach can be applied outside

national jurisdiction and facilitates co-operation between States. A suitable RFMO could be NASCO since the pink salmon is a potential threat to native salmonid population. There is coverage through national legislation and international agreement that can allow for managing the pink salmon within, beyond and across EEZs through RFMOs.

To sum it up, whether the pink salmon is in Norway to stay is a matter of co-operation and co-ordination over a larger area and across borders. As Pearce argues, “nature does not go in reverse”, but it might be possible to do damage control. The pink salmon is likely a visitor that has come to stay based on its biological characteristics and favourable conditions due to climate change, but its population might be kept under control and this would minimize the risk. Observation and catch of pink salmon will most likely continue to transpire in Norway, but its potential threat of impacting the ecosystem could be minimized if the right measures are implemented.

6 References

Artsdatabanken (2018, u.d) Kongekrabbe Paralithodes camtschaticus. Retrieved 01.05.2020 from https://www.artsdatabanken.no/Fremmedarter/2018/N/771

Artsdatabanken. (2018, 14.10.2019). Risikokategorier og kriterier. Fremmede arter i Norge – med økologisk risiko 2018. Retrieved 03.10.2019 from https://www.artsdatabanken.no/Pages/239659

Artsdatabanken, n. (2014, 21.02.2018). About Norwegian Biodiversity Information Centre. Retrieved 19.10.2019 from https://www.artsdatabanken.no/Fremmedarter/2018/N/771 https://www.biodiversity.no/Pages/135580/About_Norwegian_Biodiversity_Information_Centre

Bern convention (1979). Convention on the Conservation of European Wildlife and Natural Habitats ,19.09. 1979 ETS No.104. Bern. Retrieved from https://www.coe.int/en/web/conventions/full-list/-/conventions/treaty/104

CBD (1992). Convention on biological diversity (CBD),05-06-1992 nr 1 Multilateral. Rio de Janeiro. Retrieved from https://lovdata.no/dokument/TRAKTATEN/traktat/1992-06-05-1?q=cbd

CBD (2002). Sixth Ordinary Meeting of the Conference of the Parties to the Convention on Biological Diversity, 07-19 april 2002. Haque. Retrieved from https://www.cbd.int/meetings/COP-06.

Chew, M. K., & Hamilton, A. L. (2011). The rise and fall of biotic nativeness: a historical perspective. *Fifty years of invasion ecology: the legacy of Charles Elton* (1st ed.), 35-48.

CMS. (1979). *Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention or CMS)*, 23-06-1979 nr 1 Multilateral. Retrieved from https://www.cms.int/en/convention-text.

Cochrane, K. L., & Garcia, S. M. (Eds.). (2009). A fishery manager's guidebook. John Wiley & Sons.

Fiskeri- og kystdepartement. (2007). *Forvaltning av kongekrabbe* (Forvaltningplan) (St. meld. nr. 40 2006–2007). Retrived from https://www.regjeringen.no/contentassets/3a82509cc5694fa395654e4b01f3a0c5/no/pdfs/stm200620070040000dddpdfs.pdf

Forsgren E, Hestehagen, T., Finstad, AG., Wienerroither, R., Nedreaas, K. & Bjelland, O. (2018, 5. juni). Oncorhynchus gorbuscha, vurdering av økologisk risiko. . *Fremmedartslista 2018.* Retrieved from https://www.artsdatabanken.no/Fremmedarter/2018/N/29

Forskrift om fremmede organismer (2015). (FOR-2015-06-19-716). Retrieved from https://lovdata.no/dokument/SF/forskrift/2015-06-19-716?q=forskrift%20om%20fremmede%20organismer

Frank, D. M. (2019). Disagreement or denialism? "Invasive species denialism" and ethical disagreement in science. *Synthese*. doi:10.1007/s11229-019-02259-w

Gjelland, K. Ø., Sandlund, N. O. T., & Kart, N. faktaark. Retrived 05.10.2019 from http://www2.artsdatabanken.no/faktaark/Faktaark283.pdf%C2%A0 .

Hilmo, S. H. O. (2015). Klimaendringar og framande artar aukar i betydning. Norsk raudliste for artar 2015. Retrieved 22.01.2020 from http://www.artsdatabanken.no/Rodliste/Klimaendringer

IUCN (2000). *IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species* (rep-2000-052). Retrieved 15.10.2019 from https://portals.iucn.org/library/efiles/documents/Rep-2000-052.pdf

Johnson, R. B., & Christensen, L. (2019). *Educational research: Quantitative, qualitative, and mixed approaches*: SAGE Publications, Incorporated.

Klima- og miljødepartementet (2015-2016). *Natur for livet – Norsk handlingsplan for naturmangfold* (Meld. St. 14 - 2015–2016). Retrieved from https://www.regjeringen.no/no/dokumenter/meld.-st.-14-20152016/id2468099/?ch=1

Lakse- og innlandsfiskloven – laksfl (1992). Lov om laksefisk og innlandsfisk (LOV-1992-05-15-47). Retrieved from: https://lovdata.no/dokument/NL/lov/1992-05-15-47?q=laks

Miljødirektoratet (2016). *Handlingsplan stillehavsøsters (Crassostrea gigas)*. Retrieved from https://www.miljodirektoratet.no/globalassets/publikasjoner/M588/M588.pdf.

Miljødirektoratet (u.d.). Statens naturoppsyn (SNO). Retrieved 02.02.2020 from https://www.miljodirektoratet.no/om-oss/miljodirektoratets-organisasjon/statens-naturoppsyn/

Miljødirektoratet, n (u.d., u.d.). Fremmede arter. Retrieved 02.02.2020 from https://www.miljodirektoratet.no/ansvarsomrader/arter-naturtyper/fremmede-arter/

Miljødirektoratet (2019). 28 tiltak mot fremmede arter. Retrieved 26.03.2020 from https://www.miljodirektoratet.no/aktuelt/nyheter/2019/juni-2019/28-tiltak-mot-fremmede-arter/

Miljøverndepartementet. (2012). *Naturmangfoldloven kapittel II, Alminnelige bestemmelser ombærekraftig bruk - en praktisk innføring*. Oslo, Retrieved from https://www.regjeringen.no/contentassets/76ba044f8515433c93c259e7e86420f4/t-1554.pdf.

Miljøverndirektoratet. (2007). *Tverrsektoriell nasjonal strategi og tiltak mot fremmede skadelige arter*. Miljøverndepartementet, Retrieved from https://www.regjeringen.no/globalassets/upload/md/vedlegg/planer/t-1460.pdf.

Mo, T. A., Thorstad, E. B., Sandlund, O. T., Berntsen, H. H., Fiske, P., & Uglem, I. (2018). The pink salmon invasion: a Norwegian perspective. *Journal of fish biology, 93*(1), 5-7.

Moore, P. (2005). Overview of selected international agreements related to alien species in aquatic ecosystems. *International Mechanisms for the Control and Responsible Use of Alien Species in Aquatic Ecosystems: Report of an Ad Hoc Expert Consultation, 27-30 August 2003, Xishuangbanna, People's Republic of China*, 51.

Naturmangfoldloven - nml (2009). Lov om forvaltning av naturens mangfold (LOV-2009-06-19-100). Retrieved from: https://lovdata.no/dokument/LTI/lov/2009-06-19-100

NASCO. (u.d., 26.10. 2019). North Atlantic Salmon Conservation Organization - conserving and restoring wild salmon. Retrieved 25.01.2020 from http://www.nasco.int/about.html

NASCO (2019). *Report from the Tromsø Symposium on the Recommendations to Address Future Management Challenges* (CNL(19)16). Retrieved from http://www.nasco.int/pdf/2019%20papers/CNL(19)16_Report%20from%20the%20Troms%C3%B8%20Symposium%20on%20the%20Recommendations%20to%20Address%20Future%20Management%20Challenges%20.pdf

Norwegian Ministry of the Environment (2007). *Strategy on Invasive Alien Species.* Retrieved from https://www.regjeringen.no/globalassets/upload/md/vedlegg/planer/t-1460_eng.pdf

Pearce, F. (2015). *The new wild: why invasive species will be nature's salvation*: Beacon Press.

Pimentel, D., Zuniga, R., & Morrison, D. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics, 52*(3), 273-288. doi:https://doi.org/10.1016/j.ecolecon.2004.10.002

Regjeringen.no (29.07.2019). Fremmede arter. Retrieved 20.10.2019 from https://www.regjeringen.no/no/tema/klima-og-miljo/naturmangfold/innsiktsartikler-naturmangfold/fremmede_arter/id2076763/

Regjeringen.no (2014, 13.10). Ansvarsområder og oppgaver i Klima- og miljødepartementet. Retrieved 03.02.2020 from website: https://www.regjeringen.no/no/dep/kld/dep/id673/

Regjeringen.no (2014, 12.03). Norges økonomiske sone. Retrived 15.04.2020 from https://www.regjeringen.no/no/tema/mat-fiske-og-landbruk/fiskeri-og-havbruk/1/fiskeri/internasjonalt-fiskerisamarbeid/internasjonalt/norges-okonomiske-sone/id434515/

Sagoff, M. (2019). Fact and value in invasion biology. *Conservation Biology*.

Sander, G., (2018). *Implementation of ecosystem-based ocean management* (Dissortation). UiT The Arctic University of Norway, Faculty of Biosciences, Fisheries and Economics, The Norwegian College of Fishery Science, Tromsø.

Sandlund, O. T., Berntsen, H. H., Fiske, P., Kuusela, J., Muladal, R., Niemelä, E., Uglem, I., Forseth, T., Mo, T. A., Thorstad, E. B., Veselov, A. E., Vollset, K. W. & Zubchenko, A. V. (2019). Pink salmon in Norway: the reluctant invader. *Biological Invasions, 21*(4), 1033-1054.

Sethi, S. A. (2010). Risk management for fisheries. *Fish and fisheries, 11*(4), 341-365. doi:10.1111/j.1467-2979.2010.00363.x

Sundet, J. H., & Hoel, A. H. (2016). The Norwegian management of an introduced species: the Arctic red king crab fishery. *Marine Policy, 72*, 278-284.

Thagaard, T. (2013). *Systematikk og innlevelse : en innføring i kvalitativ metode* (4. utg. ed.). Bergen: Fagbokforl.

The Constitution (1814). The Constitution of the Kingdom of Norway (LOV-1814-05-17). Retrieved from: https://lovdata.no/dokument/NLE/lov/1814-05-17

UNCLOS (1982). United Nations convention on the law of the sea (10-12-1982 nr 1 Multilateral). Retrieved from: https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf

UNFSA (1996). The United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks (04-08-1995 nr 1 Multilateral). Retrieved from: https://www.un.org/Depts/los/convention_agreements/texts/fish_stocks_agreement/CONF164_37.htm

VKM. (u.d., u.d.). Om VKM/ uavhengig og tverrfaglig. Retrieved 15.02.2020 from https://vkm.no/vkm/omvkm/uavhengigogtverrfaglig.4.175083d415c86c573b57f712.html

VKM, Hindar, K., Hole, L.R., Kausrud, K., Malmstrøm, M., Rimstad, E., Robertson, L.,… & Velle, G. (2020). *Assessment of the risk to Norwegian biodiversity and aquaculture from pink salmon (Oncorhynchus gorbuscha). Scientific Opinion of the Panel on Alien Organisms and Trade in Endangered Species (CITES).* VKM report 2020:01, ISBN: 978-82-8259-334-2, ISSN: 2535-4019. Norwegian Scientific Committee for Food and Environment (VKM), Oslo, Norway. Retrieved from: https://vkm.no/download/18.7b86d0cd16f9471337b515cd/1579076543600/Assessment%20of%20the%20risk%20to%20Norwegian%20biodiversity%20and%20aquaculture%20from%20pink%20salmon%20(Oncorhynchus%20gorbuscha).pdf

Winter, S. C. (2012). Implementation perspectives: Status and reconsideration. *The SAGE handbook of public administration*, 265-278.