Chapter 13
Importance of Consideration of Climate Change at Managing Fish Stocks: A Case of Northern Russian Fisheries

Dmitry Lajus, Daria Stogova, and Julia Lajus

Abstract Effect of climate change on the populations of commercial fish is widely recognized. However, this recognition is currently insufficient and climate parameters are not incorporated into fishery forecasting models. Major fisheries of northern Russia targeting Alaska pollock, Pacific salmon in the North Pacific, and Atlantic cod in the Barents Sea are now in a good shape and showing record catches. This review discusses how climate change should be taken into account in the management of northern fish stocks in Russia. Given that climate conditions are currently favorable for these fisheries, it is difficult to assess the effectiveness of management system and predict how it will behave under less favorable climatic situation. Climate change might play a positive role in short-term perspective, but its role may be even negative in long-term perspective because of the possibility that the management system might lose its effectiveness in favorable conditions. To reduce risks for commercial fish stocks, it is necessary to incorporate an ecosystem-based approach in the management. One opportunity for that is provided by the program of ecological certification of Marine Stewardship Council (MSC) which became well established in Russia during the last decade. Without any support from the state, participants of the MSC program educate fishers, fishery managers, and governmental officers towards the use of ecosystem-based approach, specially accounting for the effect of climate change on northern Russian fisheries.

D. Lajus (✉) • D. Stogova
St. Petersburg State University, Saint Petersburg, Russia
e-mail: dlajus@gmail.com

J. Lajus
National Research University Higher School of Economics, Saint Petersburg, Russia

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13.1 Introduction

Since the development of modeling approaches to study dynamics of fish stocks of commercial fisheries[1] in the 1950s, the main aim of fisheries scientists was to determine how much fish can be withdrawn from the stocks without paying much attention to the effect of environmental factors on their population dynamics. Variation in stocks' size therefore was mostly attributed to fishing mortality (Finley 2011). Certainly, effect of weather conditions on recruitment of commercial fish was known since mid-nineteenth century at least, but these fluctuations were considered rather as random effects than as a long-term trends (Cushing 1982). After the book of Cushing provided a convincible set of examples of influence of climate on fish stocks, this influence became widely recognized among scientists, especially since the 1990s when climate change studies in general rapidly developed (Glantz 1992, 1994). By that time, in-depth analysis of several cases of overfishing, in particularly, the Pacific sardine in the 1950s (Lluch-Belda et al. 1989; MacCall 2011), and the Atlanto-Scandian herring in the 1970s (Nakken 2008) has been performed. It occurred that at the time when the overfishing happened, their decline was attributed to problems of management; in fact the overfishing coincided with a period of unfavorable climate conditions, which did not allow management to respond to the situation adequately.

A recognition of climate effects on fisheries, however, is still insufficient. According to Cheung and Pauly (2016, 86), "Of the various ways humans affect marine ecosystems, climate change may be the most insidious and unrecognized. In fact, even if they believe that it is occurring, most people think climate change is going to affect us later, and thus there is no real urgency". Although there were some attempts to formally incorporate climatic parameters into population models, these attempts have so far not been successful (King et al. 2015).

The major Russian commercial fisheries are situated in high latitudes where climate change is very pronounced now, and may thus cause a considerable effect on the stocks. All these fisheries experience a period of high, sometimes record catches, which is often attributed to effective management. A number of these fisheries were awarded with Marine Stewardship Council (MSC) certification showing recognition of management effectiveness internationally. Meantime, these fisheries targeted boreal but not Arctic species, for which warming is usually a favorable factor for their distribution and abundance (Drinkwater et al. 2006; Stige et al. 2010). This indicates that warming alone may play an important role in the current favorable status of the northern Russian fisheries. As the roles of favorable climate conditions and effective management on the good status of the fish stocks are difficult to separate from each other, it is difficult to assess the effectiveness of management system objectively and predict how it will behave under less favorable climate conditions. This review is discussing how climate change should be taken into account in management of northern fish stocks in Russia.

[1] According to the Merriam-Webster dictionary (www.merriam-webster.com), term "fishery" has the following meanings: (i) the occupation, industry, or season of taking fish or other sea animals (as sponges, shrimp, or seals): fishing, (ii) a place for catching fish or taking other sea animals, (iii) a fishing establishment, (iv) the legal right to take fish at a particular place or in particular waters, (v) the technology of fishery —usually used in plural.

13.2 Major Fisheries of Northern Russia

The major Russian fisheries comprising altogether more than a half of total fish catch of Russia, accounted almost 4.493 million metric tons (Svedenia 2015). The largest is Alaska Pollock fishery that comprises 36% of the total fish catch in Russia (Svedenia 2015) and is situated in the Far East (Sea of Okhotsk and Bering Sea). Pollock catches were high in the 1980s, but declined afterwards and have grown again during the last decades probably due to favorable climate (Klyashtorin 1998; Johnson 2016). The fishing is conducted from large vessels by using pelagic trawls. High by-catch of juvenile pollock may cause some problems in this fishery (O'Boyle et al. 2013).

Pacific salmon, represented by several species - pink, chum, sockeye, coho and chinook - are caught mostly near the Kamchatka Peninsula and Sakhalin Island in the North Pacific, comprising about 8% of the total Russian catch. Pacific salmon were abundant in the 1930–1940s, after which the stocks declined and grew again since the 1990s, showing a high positive correlation of population size with water temperatures (Beamish and Bouillon 1993; Klyashtorin 1998). Their catches approached record levels in the last decade (Irvine and Fukuwaka 2011). Most salmon are caught by trap nets - passive fishing gear installed on the salmon's spawning migration passages in the sea before they enter rivers for spawning (Fig. 13.1). Because of spawning in rivers, salmon are easily available for the local population, and illegal fishing is rather intensive and difficult to control. Illegal fishing has now reduced greatly in comparison to the 1990s when it was ubiquitous, but it still represents a common practice in the Far East (Simonova and Davydov 2016).

Fig. 13.1 Loading of pink salmon in the Northern Sakhalin Island (Photo by D. Lajus)

Another threat for the wild salmon stocks is represented by hatcheries, that are used to reduce natural mortality by incubating salmon eggs and rearing their juveniles under artificial conditions and then releasing them in the wild. The hatcheries are mostly operated in the southern part of Sakhalin Island and Kuril Islands, although they are not so numerous as in Japan, Canada and USA. Hatchery fish can compete with wild-origin fish, reducing their growth and abundance but are usually less adapted to natural environment, a characteristic that might be especially important in periods of quick climate changes.

Atlantic cod and related species such as haddock and saithe are caught in the Barents and Norwegian seas and comprise almost 11% of total Russian catch. This fishery is managed by the Joint Norwegian-Russian Fisheries Commission. The Arctic cod stock experienced significant fluctuations with high levels in the 1940–1950s, decline in the 1980s, and increase in the recent decades, following climate trends (ICES 2015 and the references herein). The catches reached the record level in 2014 (ICES 2015). The main fishing gear for catching this species is the bottom trawl, that heavily contacts with the sea bottom during fishing operations and may cause serious damage to bottom communities. It also easily results to a by-catch, formed from a comparatively large proportion of non-target species. Research in the Barents Sea has proved a negative effect of bottom trawls on benthic organisms (Denisenko and Zgurovsky 2013). Now codfish fisheries in the Arctic are considered as an example of excellent management (Pristupa et al. 2016), but only a decade ago the same fisheries caused serious concerns due to illegal fishing and overcapacity of fishing fleet (Kalentchenko et al. 2005).

13.3 Risks for Fish Stocks Associated with Climate Change

The analysis of the historical catch dynamics of the forementioned fish stocks shows that they are in accordance with predictions based on analysis of fisheries worldwide (Cheung et al. 2008, 2009; Fernandes et al. 2013; Cheung and Pauly 2016), i.e. they experience a growth in the warmer periods and decline during the colder ones. Another conclusion that can be drawn from these descriptions is that all these fisheries have management problems imposing risks to their sustainability, such as illegal fishing, destruction of bottom communities, and by-catch of juvenile individuals or non-target species. These problems may not play important role in a period of favorable climate conditions, but in a situation of unfavorable climate conditions they may increase the negative role of climate change, causing a serious problem for the sustainability of fish stocks.

Even if climate conditions will stay favorable, the biotic situation in the ecosystems will eventually change -mostly due to changes in populations of forage organisms and predators, and appearance of introduced species, which is predicted to be quite intensive in high latitudes (Cheung et al. 2009). These factors may cause a change of dominant species and thus require an adequate response of management system. This is possible only if all available information about populations of com-

mercial species and their biotic and abiotic interactions will be taken into consideration. Such approach is called "ecosystem-based management". This approach was conceptually developed in the 1990s (Slocombe 1993; McLeod and Leslie 2009), but until now it has not been very common to apply it in practice because of insufficient knowledge about the patterns and nature of processes in the marine ecosystems. In the case of Russian fisheries, climate change may play a positive role in short-term perspective, but its role may be counterwise in a long-term perspective because of the possibility that the management system may lose its effectiveness under the current favorable conditions.

13.4 How to Reduce Risks for Fisheries?

In order to introduce ecosystem-based approach to fishery management in long-term perspective, it is necessary to modify the higher education both in specialized and general universities by introducing relevant courses into the curriculum. At the same time, there are also approaches that do not rely on governmental funding. In particularly, environmental non-governmental organizations, such as the World Wildlife Fund, actively operating in Russia, traditionally play active role in the education of general public. The understanding of the importance of the fisheries sustainability is too weak now in the society, and special effort is required to improve that. Public education towards consuming sustainable seafood began only few years ago by publication of the first seafood consumer guide in Russian (Lajus et al. 2010). Other publications on sustainable fisheries were devoted to principles of ecological certification (Spiridonov and Zgurovsky 2003), illegal fishing of Kamchatka salmon (Dronova and Spiridonov 2008), comparison of consequences of long-line and bottom trawl fishing (Grekov and Pavlenko 2011), critical analysis of Russian fisheries against provisions of Code of conduct of responsible fisheries (Zgurovsky et al. 2013) and analysis of fisheries-related threats to the Arctic ecosystem (Bokhanov et al. 2013).

In short-term perspective, one approach is the introduction of ecological certifications. Among a number of existing certification systems, the most demanded is a voluntary certification according to the standards of Marine Stewardship Council (MSC). MSC develops standards for certification, and the certification itself is performed by an independent company. Certified fisheries obtain marked advantages. MSC program is quite well established in Europe and North America, but comparatively new for Russia with its very different civil and expert structures. By now, in total 15 fisheries are certified, and among them are the fisheries described in this chapter. Only fisheries that deal with export production participate in the program, because of absence of demand on certified fish on the Russian market.

Participation in the MSC program requires all participants – company managers, governmental authorities, researchers, independent experts –very profound understanding of its standards, consisting of three principles: maintenance of healthy status of target species, limited ecosystem effect of fishing operations, and effective

management. During the almost decade of operation of the MSC program in Russia, there has been several publications about MSC principles and process. Also, several seminars have been organized by environmental NGOs such as WWF, MSC, Wild Salmon Center (WSC), Ocean Outcomes (O2) and fisheries clients in Moscow, Murmansk and the Far East. The participants of these seminars have been fishers, vessel owners and principal crew, governmental officers, independent experts. As a consequence of these activities, there is now a number of experts in Russia who are familiar with the process and principles of the MSC program. There is as well a Russian MSC representative, and a Russian certification body. Therefore, the MSC certification currently represents a well-established process that may serve as a framework for spreading the principles of ecosystem-based management to fisheries. Climate change problematics certainly plays a key role in the introduction of ecosystem-based approach to northern Russian fisheries, because climate change is most pronounced in high latitudes and because commercial species are in general biologically very sensitive to such changes. Climate effects are not linear and thus very difficult to forecast, and therefore only cooperative efforts of both managers, researchers and fishers allow to adequately response to their challenges.

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