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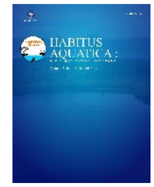

Fenomena *Isoyake* di hamparan rumput laut *Saccharina japonica* di Primorskii, *far-eas*t Rusia

Occurrence of Isoyake in kelp beds of Saccharina japonica in Primorskii, far-east Russia

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ABSTRAK

Terjadi penurunan jumlah keberadaan rumput laut *Saccharina japonica* di Primorskii, *far-east* Rusia. Sebagian besar rumput laut telah menghilang di lokasi ini, sehingga menghasilkan garis pantai tandus yang dikenal sebagai Isoyake. Survei lapangan yang dilakukan dari tahun 1975 hingga 2015 di Teluk Valentin mengungkapkan penurunan yang signifikan dalam populasi rumput laut. Penurunan ini berkorelasi dengan suhu air yang berfluktuasi. Pada periode 1980 hingga 1990 kondisi suhu perairan cenderung lebih rendah, lalu terjadi peningkatan pada periode 2000–2010, dan kembali mengalami penurunan suhu pada 2010–2019. Meskipun suhu lebih rendah setelah tahun 2010, Isoyake tetap ada. Temuan ini menekankan perlunya pemantauan berkelanjutan dan penyelidikan lebih dalam terhadap pendorong lingkungan dan ekologi di balik Isoyake, dengan implikasi bagi konservasi dan pengelolaan sumber daya rumput laut berkelanjutan di Timur Jauh Rusia.

Kata kunci: alga, Jepang, rumput laut

ABSTRACT

A decline in the abundance of the seaweed Saccharina japonica has occurred in Primorskii, far-eastern Russia. Most of the seaweed has disappeared at this location, resulting in a barren coastline known as Isoyake. Field surveys conducted from 1975 to 2015 in Valentin Bay revealed a significant decline in the seaweed population. This decline correlated with fluctuating water temperatures. In the period 1980 to 1990, water temperatures tended to be lower, then increased in the period 2000–2010, and again decreased in temperatures in 2010–2019. Despite lower temperatures after 2010, Isoyake persisted. These findings emphasize the need for continued monitoring and deeper investigation of the environmental and ecological drivers behind Isoyake, with implications for conservation and sustainable management of seaweed resources in far-east Russia.

Keywords: *algae, seaweed, Japan*

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1. Introduction

The kelp *Saccharina japonica* (Miyabe) N. Yotsukura, S. Kawashima, T. Kawai, T. Abe *et* L.D. Druehl, commonly known as 'Kombu' in Japan (Yotsukura *et al*. 2008), is an important algal resource found in northern areas of Japan and far-east Russia. It is found in the northern areas of the Sea of Japan, Hokkaido, Japan, and the southern parts of Primorskii and Sakhalin, Russia (Yotsukura *et al*. 2008; Kawai *et al*. 2014; Kawai *et al*. 2015). The volume of kelp harvested in Japan has sharply decreased, leading to various studies aimed at increasing kelp populations (Akaike *et al*. 1998; Kuribayashi *et al*. 2017; Nabata *et al*. 1992). While the current state of kelp fisheries in far-east Russia has been reviewed (Krupnova 2012; Galanin and Repnikova 2014; Kawai *et al*. 2014), field surveys of kelp resources in southern Primorskii far-east Russia remain limited.

This study focuses on a field survey conducted in Primorskii, where a once-dominant *S. japonica* kelp community has largely disappeared, leaving barren rocky coastlines known as Isoyake. In Japan, *S. japonica* is divided into several varieties, including *S. japonica* var. *diabolica*, *S. japonica* var. *japonica*, *S. japonica* var. *ochotensis*, and *S. japonica* var. *religiosa*. However, distinguishing between these varieties in Russia proves challenging. Therefore, this study refers to all kelp as *Saccharina japonica*.

2. Methods

2.1. Time and Location

Sampling was conducted at the Marine Research Station of the National Institution of Russia, Pacific Scientific Research Fisheries Centre, in Valentin Bay, Primorskii, far-east Russia (43.115193N, 134.320733E) (Figure 1). The sampling site was the rocky shore with bed rock and large boulders (over 1 m diameter), facing the open sea, kelp individuals from a 0–10 m depth range from the shoreline were searched for and collected by divers. Field observations are arranged for every month from April to November, for the period of 1975–1979 and 2006–2010, and on 15th July 2015.

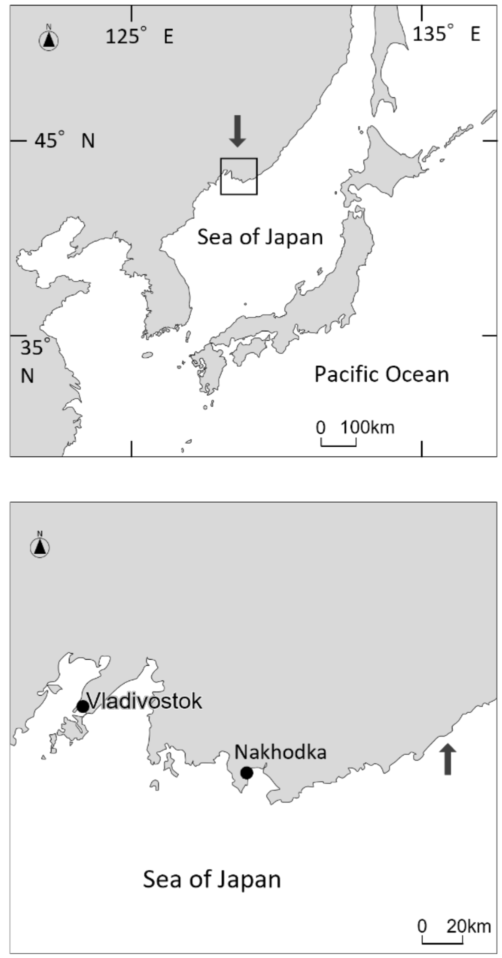

Figure 1. Map showing study site of sampling station.

Black arrow indicates sampling point of the present study.

2.2. Data Collection

Saccharina japonica is perennial except *S. japonicus* var. *religiosa*, they can grow for two years (Yotsukura *et al*. 2008). Age of the collected samples were differentiated based on Yotsukura *et al*. (2008), new haptera arise in tiers and each new tier covers the preceding tier, forming conical holdfasts which are defined as biennial sporophytes and only new haptera which form as flat and plate-like holdfasts are denied as annual sporophytes.

Sea surface water temperature in the field was analyzed using "Description of Daily Sea Surface Analysis for Climate Monitoring and Predictions (COBE-SST version 1)".

3. Results and Discussion

Figure 2 illustrates the changes in water temperature over time. Water temperatures were lower during the period from 1980 to 1990, increased from 2000 to 2010, and then declined from 2010 to 2019.

The second-year kelp sporophytes were abundant from 1975 to 1979, from 2006 to 2010, but the kelp and other erect type sea algae could not observe in 2015. Only coralline algae, the sea urchin, *Mesocentrotus nudus* and the starfish *Patiria pectinifera* were observed (Figure 3). In Russia, water temperature from 2010 to 2020 was lower than during 2000 to 2010 (Figure 2), but Isoyake in far-east Russia occurred after 2010.

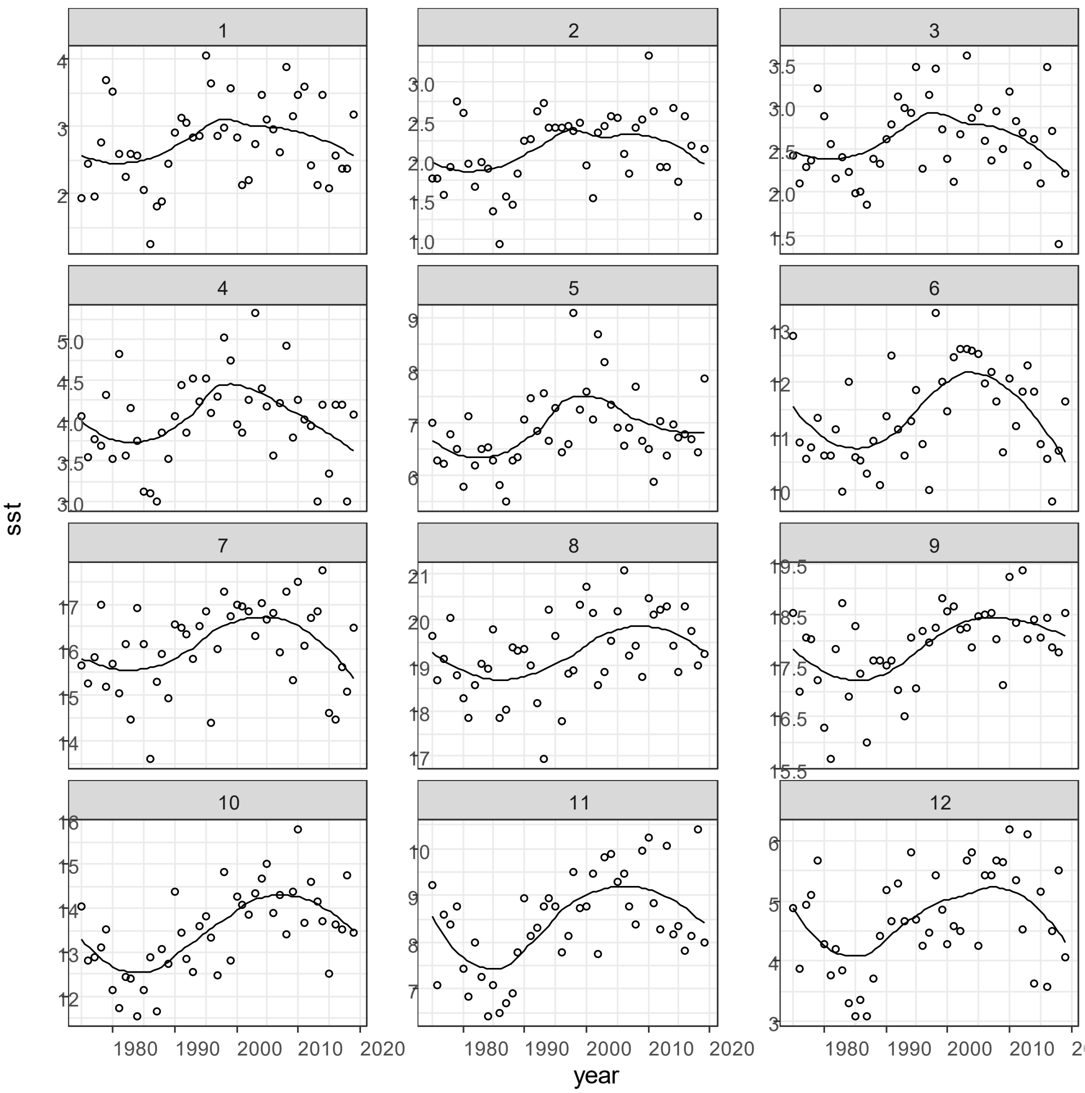

Figure 2. Water temperature off-shore of Primorskii, Sea of Japan, far-east Russia.

Monthly mean sea surface temperature (SST, °C) with curve fit lines are depicted based on the Description of Daily Sea Surface Analysis for Climate Monitoring and Predictions COBE-SST version 1, (https://ds.data.jma.go.jp/tcc/tcc/products/elnino/cobesst_doc.html downloaded on 4th April 2020). Number means months.

The study observed a decrease in *Saccharina japonica* populations, which reflects wider trends in marine ecosystems. Fluctuating temperatures and other environmental factors have a significant impact on the growth and survival of kelp. The thermal regimes showed lower water temperatures from 1980 to 1990, an increase from 2000 to 2010, and a subsequent decline from 2010 to 2019, indicating that these changes may contribute to the instability of kelp populations in the region.

The findings suggest that kelp is sensitive to environmental changes, as shown by the presence of abundant second-year kelp sporophytes during 1975–1979 and 2006–2010, followed by their near absence in 2015. In 2015, there was an absence of kelp and other erect sea algae, while coralline algae, sea urchins, and starfish were prevalent, indicating a shift towards a barren state known as Isoyake. This phenomenon resembles the Isoyake observed in other regions where reductions in kelp resources and communities have been documented due to increasing water temperatures leading to urchin domination and substrate coverage by coralline algae. However, the occurrence of Isoyake in far-east Russia may not be directly related to higher water temperatures, suggesting potential differences between the Isoyake phenomena in Russia and Japan. The persistence of Isoyake in far-east Russia, despite lower water temperatures from 2010 to 2020, indicates the possibility of other contributing factors such as herbivore pressure, nutrient availability, or pollution inhibiting kelp recovery.

The study emphasizes the need for a deeper investigation into the specific environmental and ecological conditions in the region to address the underlying causes of Isoyake and promote kelp forest recovery. Additionally, efforts to assess the specific impacts on various kelp populations are complicated by the challenge in distinguishing between different varieties of S. japonica in Russia, highlighting the importance of refined taxonomic studies to better understand the genetic and ecological diversity of kelp and their responses to environmental change.

Figure 3. Shore of sampling station at the Marine Research Station of National Institution of Russia, Pacific Scientific Research Fisheries Centre in Valentin Bay, Primorskii, Sea of Japan, far-east Russia.

Upper, above water view of the sampling site; lower, underwater photo of typical conditions at the site.

4. Conclusion

Resources of the kelp in Primorskii should be monitored with yearly change of water temperature in future for sustainable utilize and conservation of kelp resources in Russia and Japan.

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