Journal of Coastal and Ocean Sciences
Volume 6 No. 1, January 2025: 10-15

e-issn: 2746-4512
p-issn: 2745-4355

Distribution of Sea Surface Temperature and Salinity in the Karimata Strait

Amir Yarkhasy Yuliardi[1*], Randi Firdaus[2], Septy Heltria[3], Luhur Moekti Prayogo[4], Agung Tri Nugroho[1], Diah Ayu Rahmalia[1], Ratna Juita Sari[1]

[1]Department of Marine Science, Faculty of Fisheries and Marine Science, Universitas Jenderal Soedirman, Purwokerto, 53122 Indonesia

[2]Center for Marine Meteorology, Agency for Meteorology Climatology and Geophysics (BMKG), Jakarta 10610 Indonesia

[3]Department of Fisheries, Faculty of Animal Science, Universitas Jambi, Jambi 36122 Indonesia

[4]Department of Marine Science, Faculty of Fisheries and Marine, Universitas PGRI Ronggolawe, Tuban 62381 Indonesia

Corresponding Author: amiryarkhasy@gmail.com

Received: 10 September 2024; Accepted: 10 December 2024

ABSTRACT

The Karimata Strait possesses unique characteristics influenced by its geographical location and the local, regional, and global impacts on its physical, biological, and chemical parameters, contributing to its potential as a significant fishing ground. This study aims to observe and analyze the physical oceanographic parameters, including temperature, salinity, and sea surface currents, within the Karimata Strait. The dataset comprises monthly averaged data, resulting in a single representative value for each month. Key physical parameters examined include temperature, salinity, and the horizontal (u) and vertical (v) current components. The patterns of sea surface temperature (SST) and salinity distribution in the Karimata Strait exhibit significant variations between the west and east monsoons. During the west monsoon season, the South China Sea influenced the region with lower SST and higher salinity than the Java Sea. In contrast, the east monsoon demonstrates an inverse pattern with warmer, fresher waters from the Java Sea moving towards the strait. Additionally, the horizontal distribution of these parameters highlights the critical role of sea currents in dispersing physical oceanographic characteristics within the region. These findings underscore the dynamic nature of the Karimata Strait's oceanography, influenced by seasonal monsoon shifts, water masses from adjacent seas, and freshwater inputs from rivers, crucial for understanding the broader Indonesian Throughflow (ITF) system and its implications for regional climate and marine ecosystems.

Keywords: East Season; Karimata Strait; Sea Surface Salinity; Sea Surface Temperature.

1. INTRODUCTION

Indonesia, located on the equator, has a tropical climate with two main seasons: the west (December-February) and the east (June-August). The monsoon movement is the primary cause of these seasonal changes, with the west monsoon occurring when the sun is south of the equator, causing higher air pressure and winds blowing from Asia towards Australia, and vice versa during the east monsoon (Pertiwi et al., 2015). Besides monsoonal circulation, the Indonesian region is also influenced by local and global phenomena such as the Hadley circulation, Walker circulation, ENSO, and IOD, which affect sea surface temperature through the hydrological cycle (Fadholi, 2013).

Sea water masses have distinct surface temperature and salinity characteristics, both horizontally and vertically (Wardani et al., 2014; Purba & Pranowo, 2015). The Karimata Strait, located between the South China Sea and the Java Sea and between Sumatra and Kalimantan Islands, has a width of approximately 220 km and a depth of less than 50 m (Fang et al., 2002). Additionally, the Gaspar Strait between Bangka Island and Belitung Island is about half the width of the Karimata Strait and has a depth of less than 40 m.

The Karimata Strait has unique geographical locations and local, regional, and global influences on its physical, biological, and chemical parameters. Its potential as a significant fishing ground is also noteworthy. As explained by Susanto et al. (2006), during July-

October, the Karimata Strait has high chlorophyll content. Research by Harahap & Yunarsah (2012) also highlighted the potential of the Karimata Strait as a fishing ground, which was further evidenced by Prasetyo et al. (2014) regarding the relationship between squid catches and chlorophyll-a and sea surface temperature. The sea surface currents in the Karimata Strait are also unique. A study by Anwar et al. (2018) showed that surface currents in this region are affected by the seasonal period and the weak and medium phases of ENSO.

In specific waters, physical factors such as precipitation, evaporation, wind speed, sunlight intensity, and other variables can affect sea surface temperature and salinity conditions (Suhana, 2018). Salinity can also be influenced by local variability in the waters. Precipitation occurring in ocean waters can reduce sea surface temperature and salinity. At the same time, the evaporation process can increase sea surface temperature and salinity due to heat flow from the air to the water surface layers (Juniarti & Jumarang, 2017).

Based on the above description, this study was conducted to observe and examine the characteristics of physical oceanographic parameters, including temperature, salinity, and sea surface currents in the Karimata Strait and their variability. This study employs a scientific approach with monthly averaged data to produce a representative monthly value. It examines the horizontal (u) and vertical (v) current components to understand the oceanographic dynamics in the Karimata Strait comprehensively.

2. RESEARCH METHOD

Time and Place

The observation stations encompass the Karimata Strait, which is directly adjacent to the northern Java Sea, Kalimantan Island, the waters of Bangka Belitung, and the southern Natuna Sea. The selection of time series observation stations considered aspects of seawater circulation patterns, freshwater runoff from the mainland, and the topography of the Karimata Strait waters. The research location is situated at coordinates 1.5°S – 4.5°S latitude and 103.5°E – 110.5°E longitude (Figure 1). The distribution patterns of physical parameters, specifically temperature and salinity, were overlaid with current directions, focusing on January to represent the west monsoon and July to represent the east monsoon. Temperature and salinity variability were also observed at four points along the water mass circulation path in the middle of the Karimata Strait. The temperature and salinity distribution patterns, overlaid with currents and time series variability, were analyzed using Ocean Data View (ODV) (Lenartz et al., 2018).

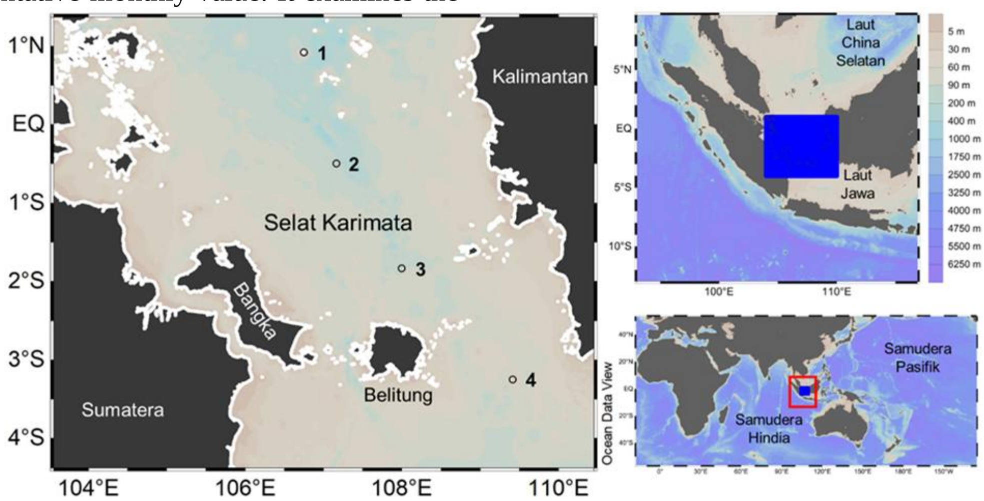

Figure 1. Research location. Map of the Karimata Strait (Selat Karimata) with observation points (1-4). The main map highlights regional bathymetry. Insets show the study area's location in Southeast Asia and globally, with color shading representing water depth.

Data Analysis

The data utilized in this study are reanalysis (assimilation) data. The dataset consists of monthly averaged data, resulting in a single representative value for each month. Key physical parameters examined include temperature, salinity, and the horizontal (u) and vertical (v) current components. Data were sourced from the Copernicus-Marine Environment Monitoring Service (CMEMS) data provider, using the product ID GLOBAL_MULTIYEAR_PHY_001_030 of the data grid type, with a spatial resolution of 0.083° x 0.083°. The dataset spans from January to December 2020, capturing the complete annual variability (Figure 2).

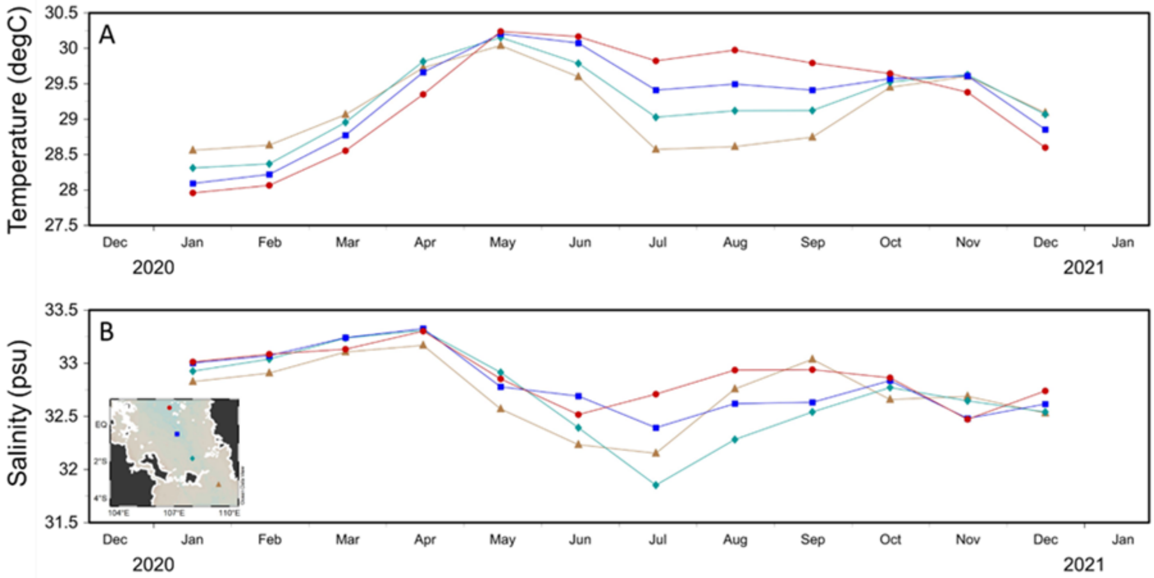

Figure 2. Time series profile of variability (A) sea surface temperature and (B) salinity at point 1 (maroon red), point 2 (blue), point 3 (tosca) and point 4 (brown)

3. RESULT AND DISCUSSION

Distribution of Sea Surface Temperature

The distribution pattern of sea surface temperature (SST) in the Karimata Strait during the west and east monsoons shows significant differences. During the west monsoon season, water masses from the South China Sea move towards the Java Sea through the Karimata Strait. This movement is accompanied by winds and surface currents flowing eastward, resulting in a distinct gradient in SST values. The colder water mass from the South China Sea entering Indonesian waters is marked by warmer temperatures following the current towards the Java Sea.

This pattern is well-documented by Sagala et al. (2014), who highlighted the temperature transition from colder to warmer due to the eastward-moving currents. In contrast, during the east monsoon, the surface water mass moves northward with weaker currents. This observation aligns with Susanto et al. (2013), who reported using ADCP data from December 2007 to November 2008 that the flow from the South China Sea through the Karimata Strait exhibits strong southward movement during the west monsoon and a weaker flow during the east monsoon.

SST during the west monsoon around islands tends to be higher compared to the east monsoon due to the influx of land-derived water through rivers. This pattern is observable along the coastlines of both large and small islands. For instance, in July, SSTs are more remarkable in the eastern regions and warmer in the western and northern regions.

Warm SSTs around Kalimantan Island, Sumatra Island, the South China Sea, and the Karimata Strait are prominently visible during the west monsoon. This is due to the wind blowing from the east to the west, carrying seawater masses with relatively lower SST from the east to the west (Siregar et al., 2017). Additional factors contributing to the higher SST in the western regions include the influence of freshwater input from rivers, which can alter the thermal characteristics of coastal waters. The interaction between freshwater input and sea surface temperatures can affect local climate patterns and marine ecosystems.

The observed SST patterns during both monsoon seasons are closely related to broader oceanographic dynamics and climatic processes. During the west monsoon, colder water masses from the South China Sea are associated with upwelling phenomena in certain areas, where surface currents bring cooler water to the surface. This can impact primary productivity in the surrounding waters, affecting marine ecosystems. Conversely, during the east monsoon, the lower SSTs may be related to reduced monsoon wind activity affecting surface currents, which may lessen vertical mixing and allow the surface layer to warm more rapidly than the west monsoon. Understanding SST patterns during the two monsoon seasons is crucial for marine resource management, including fisheries and coastal ecosystems. Variations in SST can influence species distribution and fishery productivity, as well as the health of coral reefs. Therefore, integrating SST data with information on ocean currents and climate variability is essential for optimizing management strategies and sustainable conservation practices in the Karimata Strait and surrounding regions.

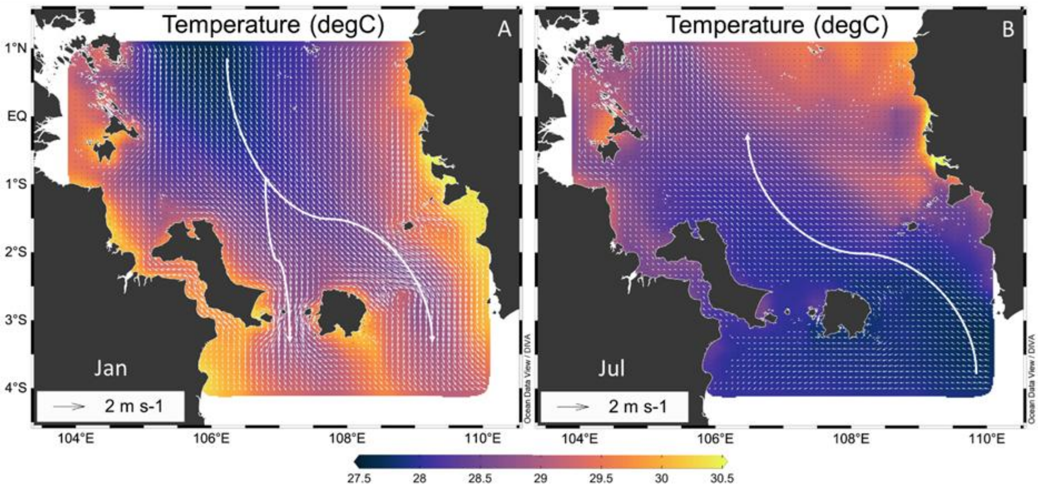

Figure 3. Horizontal distribution of sea surface temperatures in (A) January and (B) July

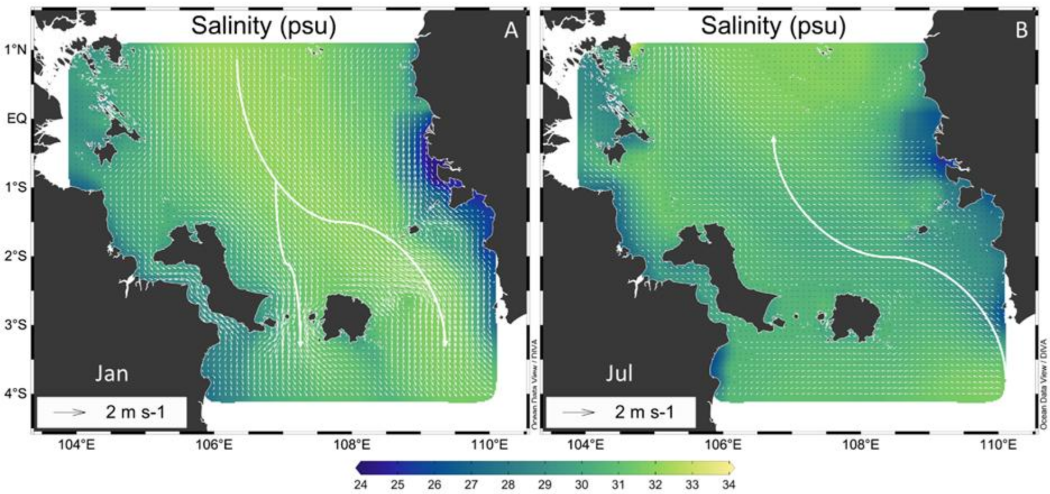

Figure 4. Horizontal distribution of salinity in (A) January and (B) July

Distribution of Sea Surface Salinity

The distribution pattern of sea surface salinity in January and July can be seen in Figure 4. Indonesian waters through the Karimata Strait before continuing into the Java Sea. This intrusion aligns with the observations by Kok et al. (2021), who found that during the west monsoon (winter), water masses characterized by lower sea surface temperatures (SST) and higher sea surface salinity (SSS) are prominent in the South China Sea compared to the Java Sea. Conversely, during the east monsoon, the situation reverses, with water masses from the Java Sea migrating towards the Karimata Strait at reduced speeds. The west monsoon is particularly notable for the southward flow of water from the South China Sea through the Karimata Strait into the Java Sea and eventually into the Indonesian Throughflow (Arlindo), as Fang et al. (2010) highlighted.

Spatially, salinity values are generally lower in the coastal regions of significant islands such as Sumatra and Kalimantan compared to the open ocean, a pattern observed throughout all seasons. This reduction in salinity is attributed to the freshwater input from rivers, which significantly impacts the coastal salinity levels. The Karimata Strait thus serves a critical role in Indonesia's interior waters, acting as a secondary pathway for the Arlindo and facilitating seasonal exchanges of water masses, each exhibiting distinct characteristics and substantial variations across seasons.

Transport variability through the Karimata Strait is often considered time-invariant, but this assumption overlooks annual changes and necessitates a revised approach to account for these variations, as discussed by Gordon et al. (2003); Tozuka et al. (2009). In comparison to its direct contributions to the Indonesian Throughflow, the Karimata Strait is increasingly recognized for its significant influence on seasonal and interannual variations in volume, heat, and freshwater transport due to its unique low salinity and high-temperature characteristics, as detailed by Samanta et al. (2021); Purba et al. (2021). This recognition underscores the importance of the Karimata Strait in understanding the broader oceanographic processes within the region and highlights the need for continued investigation into its seasonal dynamics.

4. CONCLUSION

Based on the results of research and data analysis, it can be concluded that the water mass characteristics of the Karimata Strait are significantly influenced by seasonal monsoons, specifically the west and east monsoons, as well as by the water masses from the South China Sea and the Java Sea. During the west monsoon, colder and more saline water from the South China Sea flows southward through the Karimata Strait into the Java Sea, creating a distinct temperature and salinity gradient. Conversely, the east monsoon reverses this flow, with water masses from the Java Sea moving towards the Karimata Strait at reduced speeds. These seasonal shifts in water movement are further impacted by the strength of monsoonal winds and surface currents, highlighting the dynamic nature of the marine environment in the strait. Additionally, freshwater input from mainland rivers plays a crucial role in shaping the salinity distribution in the coastal regions of significant islands such as Sumatra and Kalimantan. This influx of freshwater results in lower salinity values along the coast compared to the open ocean, indicating the considerable influence of riverine runoff on coastal salinity gradients. The horizontal distribution of temperature and salinity in the Karimata Strait is further explained by the movement of surface currents, which work to redistribute these physical parameters across the region. Understanding these interactions is essential for effective marine resource management and advancing knowledge of oceanographic processes in the Indo-Pacific region, underscoring the need for ongoing research and monitoring.

REFERENCES

Anwar, I.P., Putri, M.P., & Setiawan, A. (2018). Variation of Volume Transport and Variability of Current in Karimata and Gaspar Straits during 2010-2014 based on Numerical Modelling. *Jurnal Ilmu dan Teknologi Kelautan Tropis*, 9(2):771-780.

Fadholi, A. (2013). Studi Dampak El Nino dan Indian Ocean Dipole (IOD) terhadap Curah Hujan di Pangkal Pinang. *Jurnal Ilmu Lingkungan*, 11(1): 43-50.

Fang, G., Susanto, R.D., Wirasantosa, S., Qiao, F., Supangat, A., Fan, B., et al. (2010). Volume, Heat, and Freshwater Transports from the South China Sea to Indonesian Seas in the Boreal Winter of 2007–2008. *J. Geophys. Res.*, 115: C12020.

Fang, G., Wei, Z., & Huang, Q. (2002). Volume, Heat and Salt Transports between the Southern South China Sea and its Adjacent Waters, and their Contribution to the Indonesian Throughflow. *Oceanol. Limnol. Sin*., 33(3): 296–302.

Gordon, A.L., Susanto, R.D., & Vranes, K. (2003). Cool Indonesian Throughflow as a Consequence of Restricted Surface Layer Flow. *Nature*, 4256960: 824–828.

Harahap, S.A. & Yanuarsyah, I. (2012). Aplikasi Sistem Informasi Geografis (SIG) untuk Zonasi Jalur Penangkapan Ikan di Perairan Kalimantan Barat. *Jurnal Akuatika*, 3(1):40-48.

Juniarti, L., & Jumarang, M.I. (2017). Analisis Kondisi Suhu dan Salinitas Perairan Barat Sumatera Menggunakan Data Argo Float. *Physics Communication*, 1(1): 74–84.

Kok, P.H., Wijeratne, S., Akhir, M.F., Pattiaratchi, C., Roseli, N.H., & Ali, M.F.S. (2021). Interconnection between the Southern South China Sea and the Java Sea through the Karimata Strait. *J. Mar. Sci. Eng.*, 9 (10): 1040.

Lenartz, F., Troupin, C., & Lefebvre, W. (2018). *Data Interpolating Variational Analysis for the Generation of Atmospheric Pollution Maps at Various Scales*. In: Mensink, C., Kallos, G. (eds) Air Pollution Modeling and its Application XXV. ITM 2016. Springer Proceedings in Complexity. Springer, Cham.

Pertiwi, M.A., Kahar, S., & Marpaung, S. (2015). Analisis Korelasi Suhu Permukaan Laut terhadap Curah Hujan dengan Metode Penginderaan Jauh Tahun 2012-2013 di Kota Semarang. *Jurnal Geodesi Undip*, 4(1):61-71

Prasetyo, B.A., Hutabarat, S., & Hartoko, A. (2014). Sebaran Spasial Cumi-cumi (*Loligo Spp*.) dengan Variabel Suhu Permukaan Laut dan Klorofil-a Data Satelit Modis Aqua di Selat Karimata hingga Laut Jawa. *Diponegoro Journal of Maquares (Management of Aquatic Resources)*, 3(1): 51-60

Purba, N.P., & Pranowo, W.S. (2015). *Dinamika Oseanografi, Deskripsi Karakteristik Massa Air dan Sirkulasi Laut*. UNPAD Press.

Purba, N.P., Pranowo, W.S., Ndah, A.B., & Nanlohy, P. (2021). Seasonal Variability of Temperature, Salinity, and Surface Currents at 0° Latitude Section of Indonesia Seas. Reg. *Stud. Mar. Sci.*, 44, 101772.

Sagala, S.L., Bramawanto, R., Kuswardani, A.R.T.D., & Pranowo, W.S. (2014). Distribution of Heavy Metals in Natuna Coastal Waters. *J. Ilmu & Teknologi Kelautan Tropis*, 6(2): 297-310

Samanta, D., Goodkin, N.F., & Karnauskas, K.B. (2021). Volume and Heat Transport in the South China Sea and Maritime Continent at Present and the End of the 21st Century. *J. Geophys. Res: Oceans*, 126 (9): e2020JC016901.

Siregar, S.N., Sari, L.P., Purba, N.P., & Pranowo, W.S. (2017). The Water Mass Exchange in Java Sea due to Periodicity of Monsoon and ITF in 2015. *J. Depik*, 6(1): 44-59.

Suhana, M.P. (2018). Karakteristik Sebaran Menegak dan Melintang Suhu dan Salinitas Perairan Selatan Jawa. *Dinamika Maritim*, 6(2): 9–11

Susanto, D., Wei, Z., Adi, T.R., Fan, B., Li, S., & Fang, G. (2013). Observation of the Karimata Strait throughflow from December 2007 to November 2008. *Acta Oceanol Sin.*, 32(5):1-6.

Susanto, R.D., Moore II, T.S. & Marra, J. (2006). Ocean Color Variablity in the Indonesian Sea During the Sea WiFS Era. *Geochem., Geophys., Geosyst*., 7(5): 1525-1541.

Tozuka, T., Qu, T., Masumoto, Y., & Yamagata, T. (2009). Impacts of the South China Sea throughflow on Seasonal and Interannual Variations of the Indonesian throughflow. *Dyn. Atmosph. Oceans*, 47 (1-3): 73–85.

Wardani, R., Pronowo, W.S., & Indrayanti, E. (2014). Variability of Salinity Related to ENSO and IOD in Indian Ocean (South Java and Nusa Tenggara Seas) during Period of 2004 - 2010. *J. Harpodon Borneo*, 7(1): 9-18