

# State of the Physical, Biological and Selected Fishery Resources of Pacific Canadian Marine Ecosystems in 2024

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## 5. LAND TEMPERATURE AND HYDROLOGICAL CONDITIONS OVER B.C. IN 2024

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### 5.1. Highlights

- 2024 was the second warmest year since 1940 in B.C., exceeded only by record warm temperatures in 2023.
- Snowpack increased from well below-normal to below-normal through the early winter, decreasing again to well below-normal by late spring.
- Compared to 2023 drought conditions were less severe overall; however, basins in the Northeast continued to experience extreme drought.
- The annual mean temperature in B.C. is increasing and can be distinguished from natural variability over the analyzed period of 1940-2024. Annual precipitation, however, exhibits no significant province-wide trend over that period.

### 5.2. Introduction

Air temperature and precipitation can provide valuable insight into seasonal conditions in B.C. that have important impacts on the Northeast Pacific Ocean. This section describes the seasonal evolution of weather and snowpack conditions across B.C. in 2024 to help complement information from oceanographic data analyses. In this effort, we use monthly temperature and precipitation pseudo-observations from a global atmospheric reanalysis and both manual and automated monthly measurements of snow water equivalent from the B.C. River Forecast Center.

### 5.3. Description of the data

#### 5.3.1. *Temperature and Precipitation*

Observations of temperature and precipitation made at B.C. weather stations have been compiled on an ongoing basis since 2010 under the Climate Related Monitoring Program (CRMP; [Data Portal | Pacific Climate Impacts Consortium](#)). The dataset consists of observations from the CRMP partners—the provincially run networks, BC Hydro, the Capital Regional District, Metro Vancouver, and Rio Tinto—along with data from Environment Canada’s observing network. However, due to gaps in spatial and temporal data coverage, especially in Northern B.C., we performed the analysis (as was done for 2023; see Curry and Lang 2024) using the fifth generation European Centre for Medium-range Weather Forecasting (ECMWF) Atmospheric Reanalysis Product (ERA5). This product, which ingests some of the data contained in the CRMP database as well as from other observations, comprises a gridded representation of the historical climate spanning 1940 to present at a horizontal resolution of approximately 30 km x 30 km over the globe.

Long-term records of mean monthly temperature and precipitation were used to calculate 30-year climate normals for each month in the recent historical climate (we used 1981-2010, but our results are independent of the chosen period due the use of relative rankings; see below).

Anomalies in monthly temperature and precipitation were then computed relative to these normals for the entire 1940 to 2024 time series covering B.C. The time series of gridded anomalies were then spatially divided among the B.C. River Forecast Centre's 23 Snow Index Basin regions. Spatial averages were taken across each region to form a monthly time series of regional anomalies, which were then aggregated into seasonal and annual values. Finally, the anomalies were ranked by magnitude to assess how each season in 2024 compares with those of all previous years, for each variable. We define the first percentile and number 1 ranking as the warmest/wettest over the 85-year period of 1940 to 2024 and the highest percentile as the coldest/driest with a ranking of 85. We define broad anomaly categories ranging from record cold/record dry, much below-normal, below-normal, near normal, above-normal, much above-normal, record warm/record wet. These categories are defined by the percentile bins 100<sup>th</sup>, 100<sup>th</sup> to 90<sup>th</sup>, 90<sup>th</sup> to 66<sup>th</sup>, 66<sup>th</sup> to 33<sup>rd</sup>, 33<sup>rd</sup> to 10<sup>th</sup>, 10<sup>th</sup> to 1<sup>st</sup>, and 1<sup>st</sup>.

### **5.3.2. Snow**

Monthly measurements of snowpack are made by the Ministry of Environment and Climate Change Strategy and BC Hydro through manual snow surveys and automated snow weather stations across the province. Snowpack monitoring is important because in most basins, early spring snowpack dictates the added potential (or lack thereof) for riverine flooding during the late spring melt season. In addition, the Ministry of Forests River Forecast Centre compiles monthly snowpack data (snow water equivalent) at available stations from early January through June. In each region, the ratio (percentage) of the monthly snowpack, averaged over stations, to the 1991-2020 mean value reflects how the current year's accumulated snow amount compares with historical normals.

## **5.4. Status and trends**

### **5.4.1. Temperature and Precipitation**

In 2024, the average annual temperature across B.C. was the second warmest since 1940, with only 2023 ranking higher (Figure 5-1, left). All basins ranked in the top 6, except for Haida Gwaii. Temperatures were record warm in the seven southeastern B.C. basins. Annual precipitation anomalies were below to near normal across the province (Figure 5-1, right).

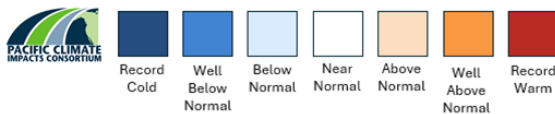
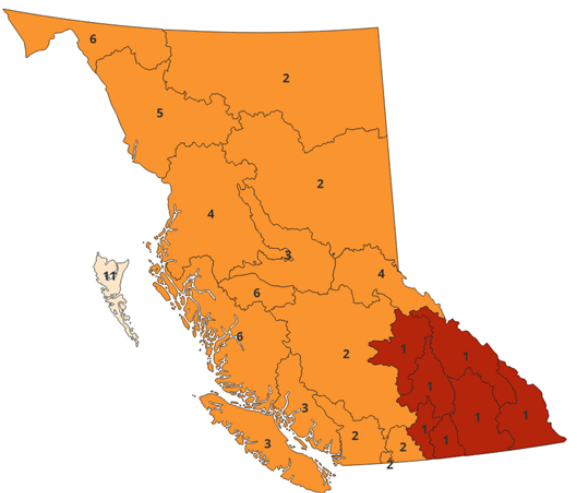
Winter temperatures were well above normal for B.C., with the warmest temperatures occurring in the southern half of the province. All basins in this area ranked 6 or higher for warmest years since 1940. Spring temperatures were above normal across the province, except for the Northwest which remained well above normal. Summer temperatures reached well above normal, mostly in the northern parts of B.C. Northern B.C. cooled in the fall to near normal temperatures, while the southern part of the province warmed above to well above normal. Notably, the Boundary region had record warm temperatures in the fall, ranking as the warmest in the 1940-2024 record.

Over the winter of 2023-2024, precipitation patterns were largely near normal over the province, meanwhile record wet precipitation occurred in the Northwest. Precipitation was below normal in the Liard, Peace, and Upper Fraser East basins. In the spring, much of B.C. was characterized by below normal precipitation, and Haida Gwaii was anomalously dry (6<sup>th</sup> driest on record). Overall, precipitation increased to near normal in the summer months. The Northwest, Stikine, Lower Fraser, and Skagit basins were above normal, while Skeena-Nass and Boundary were below normal. Fall precipitation overall remained near normal, especially in the southernmost

basins. Wet conditions spread to many central and coastal B.C. basins, and anomalously wet conditions occurred in the Peace (5<sup>th</sup> wettest), Upper Fraser West (2<sup>nd</sup> wettest), and Upper Fraser East (7<sup>th</sup> wettest) basins. Increased precipitation in these basins helped to reestablish near-normal river levels in the fall, such as observed at the Nass River above Shumal Creek (M. Schnorbus, private communication). However, fall precipitation in northern B.C., and also in two small southern basins (Skagit and Similkameen) was still below normal.

By the end of May, 89% of B.C. was rated Abnormally Dry or in Moderate to Exceptional Drought (Canadian Drought Monitor, 2024). This included 99% of B.C.'s agricultural land. While drought extent fluctuated throughout the summer months, Moderate or Exceptional droughts persisted over more than 70% of the province until the end of October.

BC Temperature: 2<sup>nd</sup>-warmest since 1940



BC Precipitation: below to near-normal



Figure 5-1. Annual anomalies for average daily mean temperature (left panel) and total precipitation (right panel) for 2024 in B.C. Colour scale is based on percentiles as provided in the text. Labels on the map refer to ranking by year (1940 – 2024) with 1 being the warmest/wettest year and 85 being the coldest/driest year. Results are based on the ERA5 Reanalysis product from ECMWF: <https://www.ecmwf.int/en/forecasts/dataset/ecmwf-reanalysis-v5>.

Using the seasonal and annual temperature and precipitation anomalies, province-wide trends are calculated for the full ERA5 record spanning 1940 through 2024. Temperature trends are more easily detected due to the smaller spatial and interannual variability compared to precipitation data. The trends in mean daily temperature are positive and statistically significant ( $p < 0.05$ ) annually and in all seasons (Table 5-1). The trends in precipitation are not statistically different from zero, except for a small increasing trend in summer. The computed trends for the 1940-2024 period are noticeably different from those for 1950-2023 presented in last year's report, mainly due to the additional 10 years added to the start of the ERA5 record.

Table 5-1. Linear trends in seasonal and annual daily mean temperature and total precipitation based on ERA5, spatially averaged over B.C. Only trends that are significant at the 5% significance level are shown. Trends are calculated from 1940-2024. Note: last year's version of the table reported trends calculated from 1950-2023.

Trends over 1940-2024	ANN	MAM	JJA	SON	DJF
Mean Temperature ( $^{\circ}\text{C decade}^{-1}$ )	+0.31	+0.28	+0.29	+0.17	+0.42
Precipitation ( $\text{mm decade}^{-1}$ )	-	-	+19	-	-

### 5.4.2. Snow

Averaged over B.C., snowpack levels ranged from 56% to 66% of normal from January 1<sup>st</sup> to June 1<sup>st</sup>, 2024 (Figure 5-2, River Forecast Center, 2024). The Vancouver Island basin remained below 49% of normal snowpack throughout winter and spring. Most of B.C. was below normal through all months, except for the Liard (>150%; May 1<sup>st</sup>), Stikine (>150%; June 1<sup>st</sup>), and Northwest (>120%; May 1<sup>st</sup>) basins. Winter precipitation for 2024 was near normal, with a slight decrease in the spring, implying that the previous year's snowpack and precipitation deficits are largely responsible for the low snowpack observed in 2024.

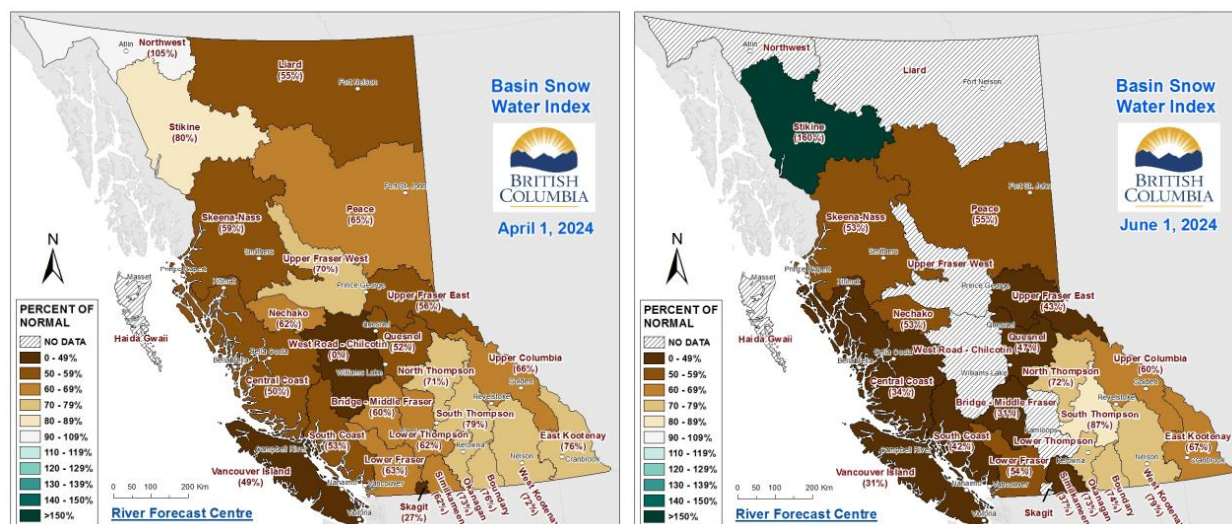


Figure 5-2. B.C. snowpack, expressed as a fraction of 1991-2020 amounts, for April (left) and June (right), 2024. Maps were produced by the B.C. Ministry of Forests River Forecast Centre (River Forecast Centre, 2024).

## 5.5. Factors behind trends and implications

Observed temperature anomalies in 2024 are consistent with ongoing warming in B.C., as indicated by the trend analysis (Table 5-1). According to ERA5, annual mean temperatures in B.C. have risen by  $0.31\text{ }^{\circ}\text{C decade}^{-1}$  on average over the last 85 years, nearly double the global mean temperature trend of  $+0.16\text{ }^{\circ}\text{C decade}^{-1}$  (using 1950-2024 ERA5 data from KNMI Climate Explorer, 2025).

Indices of tropical Pacific Ocean temperatures (e.g., the Oceanic Nino Index; Lindsey 2009) indicated a transition in ENSO state during 2024, from an El Niño state, ending in May, to the

emergence of a weak La Niña pattern by December. Hence, the latter half of 2024 was characterized by an ENSO neutral state, consistent with the near-normal precipitation patterns seen in B.C. over that time. Finally, the continuing deficit in snowpack throughout B.C. led to well below normal freshet streamflows over most of the province. Basins with a characteristic secondary streamflow peak in fall, however, displayed near-normal flows toward the end of 2024.

## 5.6. References

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