



---

## The IPHC Space-Time Explorer tool

PREPARED BY: IPHC SECRETARIAT (R. A. WEBSTER; 17 DECEMBER 2021)

---

### PURPOSE

This document provides a description of the IPHC's web-based Space-time Explorer tool for calculating space-time model estimates of survey weight and numbers per unit effort (WPUE and NPUE) for any region of Pacific halibut habitat within Convention waters, and for visualising the model-estimated spatial distribution of Pacific halibut density.

### INTRODUCTION

Since 2016, space-time modelling has been used by the IPHC to produce estimates of mean O32 WPUE (weight per unit effort), all sizes WPUE and all sizes NPUE (numbers per unit effort) indices of Pacific halibut density and abundance (Webster et al. 2020, [Webster 2021 Appendix B](#)). The modelling depends primarily on data from the IPHC's fishery-independent setline survey (FISS, [Ualesi et al, 2021](#)), but in the Bering Sea also integrates data from the National Marine Fisheries Service annual trawl survey (through a calibration calculated from years the surveys overlapped, Webster et al. 2020) and the Alaska Department of Fish and Game's annual Norton Sound trawl survey. Both surveys are fishery-independent data sources.

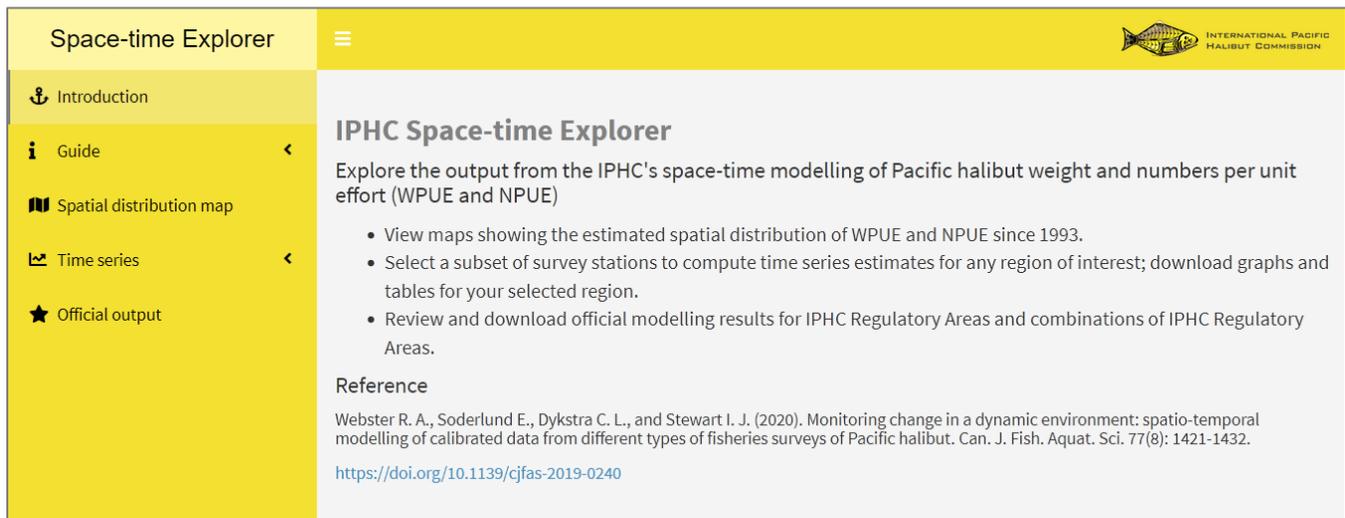
Each year, the IPHC publishes "official" output from the space-time modelling in the form of estimates of WPUE and NPUE time series by IPHC Regulatory Area and Biological Region, and for the coastwide stock in Convention waters (<https://www.iphc.int/data/time-series-datasets>). The IPHC has also fielded ad hoc requests for estimates calculated at a sub-IPHC Regulatory Area level, and Secretariat staff has met these requests as needed.

The purpose of the IPHC Space-time Explorer tool is to make the model output more readily available to the public. This tool allows users to produce estimates of WPUE and NPUE tailored to their needs or interests, and to visualize the changing distribution of Pacific halibut since 1993 (the start of the modern FISS, and the first year of input data in the space-time model).

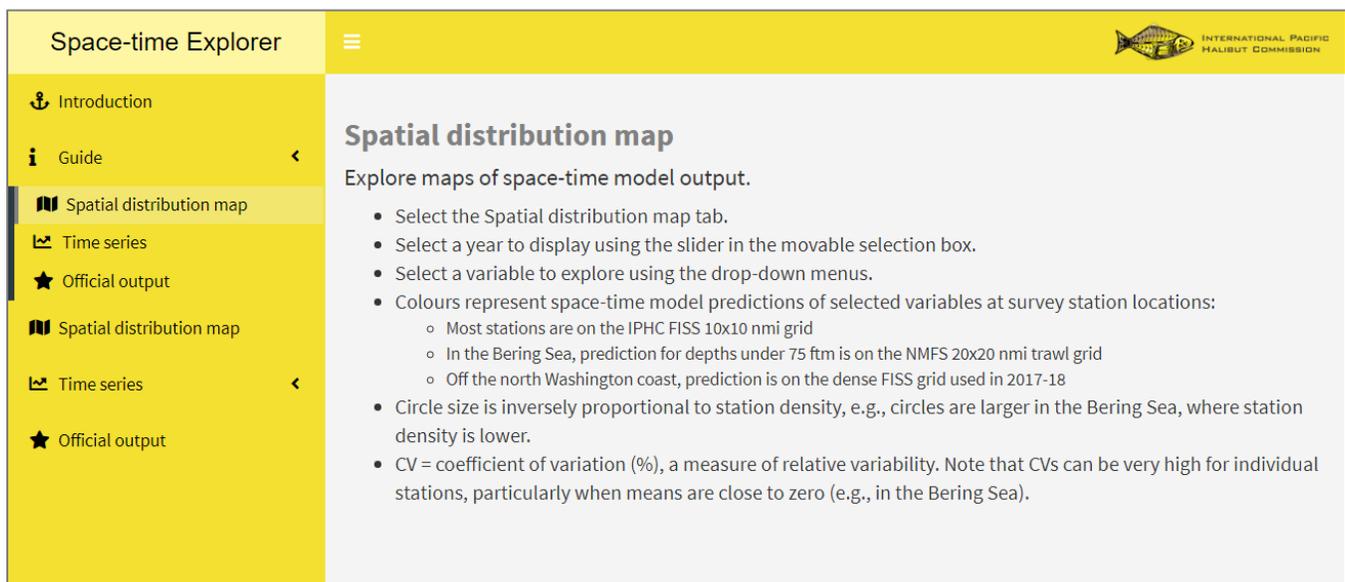
### THE SPACE-TIME EXPLORER TOOL

#### Introduction and Guide tabs

Clicking on the IPHC website link to the tool will begin the loading process. Note that it can take a minute or two for the tool (**add hyperlink here**) to appear due to the large datasets being loaded, during which time it may appear as if nothing is happening. Once loaded, the tool will open with an **Introduction** tab selected ([Figure 1](#)). A guide to the interactive pages of the tool is selected using the second tab (**Guide**), which will produce a drop-down menu with a tab of information for each of the tool's interactive components ([Figure 2](#)).



**Figure 1.** The IPHC Space-time Explorer tool showing the **Introduction** tab that appears when the tool is opened.



**Figure 2.** The Space-Time Explorer tool showing the items in the **Guide** drop-down menu with the **Spatial distribution map** tab selected.

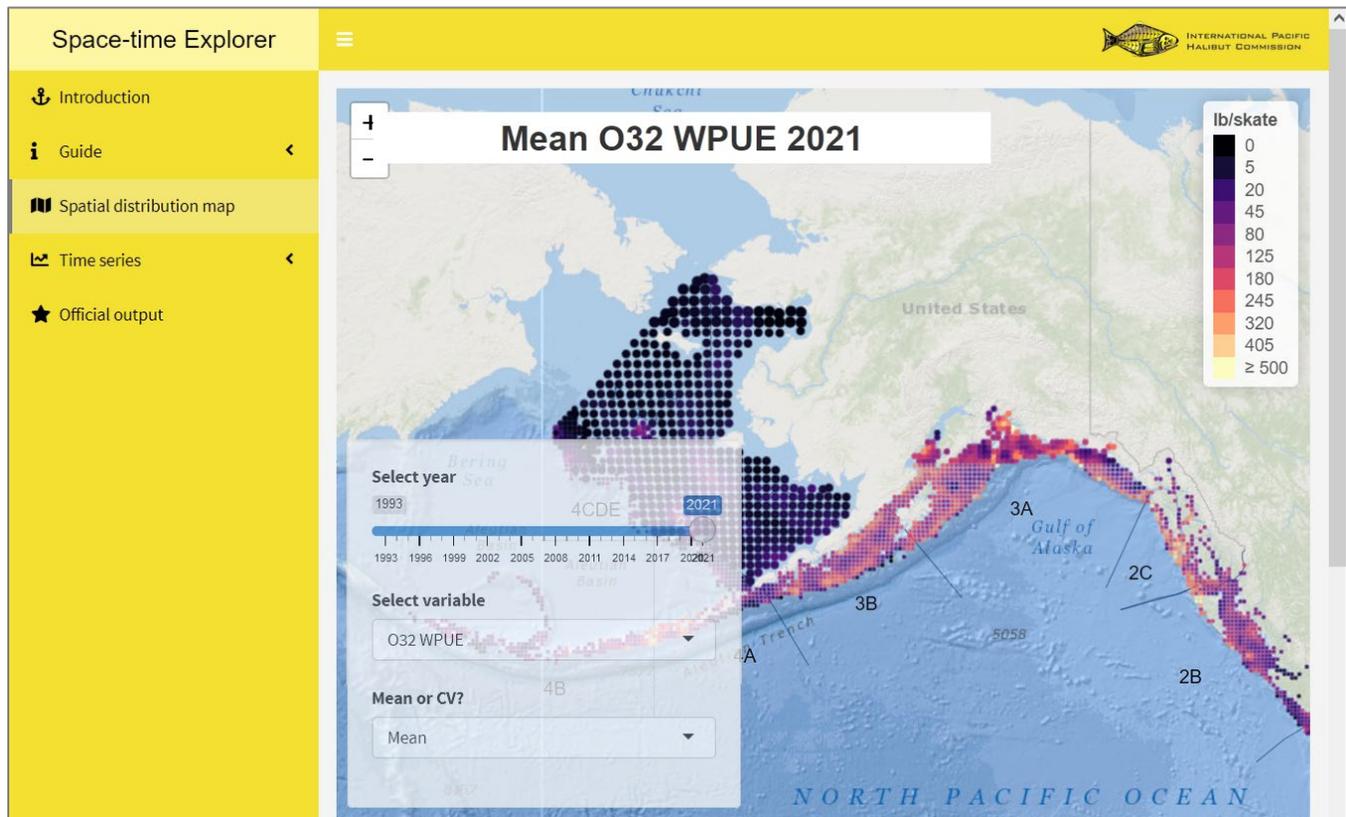
## Spatial distribution map

Selecting the **Spatial distribution map** tab ([Figure 3](#)) displays a map of survey stations represented by circles with colours representing values of WPUE or NPUE (legend at upper right). The user can zoom using the + or – buttons at upper left or the user's mouse wheel. The mouse can also be used to drag the map. The transparent dialog box is also draggable, allowing the user to move it away from an area of interest.

*Year slider:* The year for display is selected using the slider. Placing the cursor on the slider circle allows the user to move between years using the keyboard arrow keys (although sometimes it shifts by two years instead of one).

*Variable selection:* A drop-down menu gives a choice of density index to display (O32 WPUE, all sizes WPUE and all sizes NPUE)

*Mean or CV selection:* A second drop-down list allows the user to display either the station means or CVs (coefficient of variation, the ratio of the mean to standard deviation as a %). Note that the legend colour scale for means is not linear: a square root transformation was applied to the station means to make it easier to see changes in regions of low density.



**Figure 3.** The **Spatial distribution map** tab of the Space-Time Explorer tool, showing mean O32 WPUE for 2021.

## Time series

Selecting the **Time series** tab at left drops down a menu of two items. The **Station selection** tab is for the user to select which regions (groups of stations) they want to produce time series output for. Selected stations are shown with orange circles, while purple is for stations outside the selection. The resulting output is shown by selecting the **Time series output** tab. See the example in [Figures 4 and 5](#).

## Station selection

*Polygon tools:* Found at upper left, these are used to select a region, with each subsequent selection added to previous selections. Clicking the trash can icon and selecting “Clear all” removes all selected polygons.

*Check boxes:* Entire IPHC Regulatory Areas can be selected or added to polygon selections using the check boxes. To select an entire Biological Region, select all IPHC Regulatory Areas listed within that region.

*Depth range slider:* This slider allows the user to produce output for a narrower depth range than the full 0-400 fathom (0-732 m) depth range used on the FISS. It will only subset stations for selected IPHC Regulatory Areas – all stations within polygon selections will still be included,

regardless of depth. If the user desires to create a polygon that only includes a specific depth range, this can be done as follows:

- First ensure any polygons are cleared and all IPHC Regulatory Areas are unchecked
- Select the IPHC Regulatory Area(s) containing user's the region of interest
- Use the depth slider to choose a depth range - only stations within those depths will display in orange
- Carefully draw polygon(s) around stations within the region of interest, only including orange stations (zoom in for more precise polygon selection). See [Figure 6](#) for an example.
- Unselect the IPHC Regulatory Area(s), which will leave just the stations within the polygon(s) as selected (orange)

*Year range slider:* The year range slider is used to select part of the time series for output, for example if the user is only interested in estimates from the most recent years.

*Variable selection:* Choose from O32 WPUE, all sizes WPUE, or all sizes NPUE.

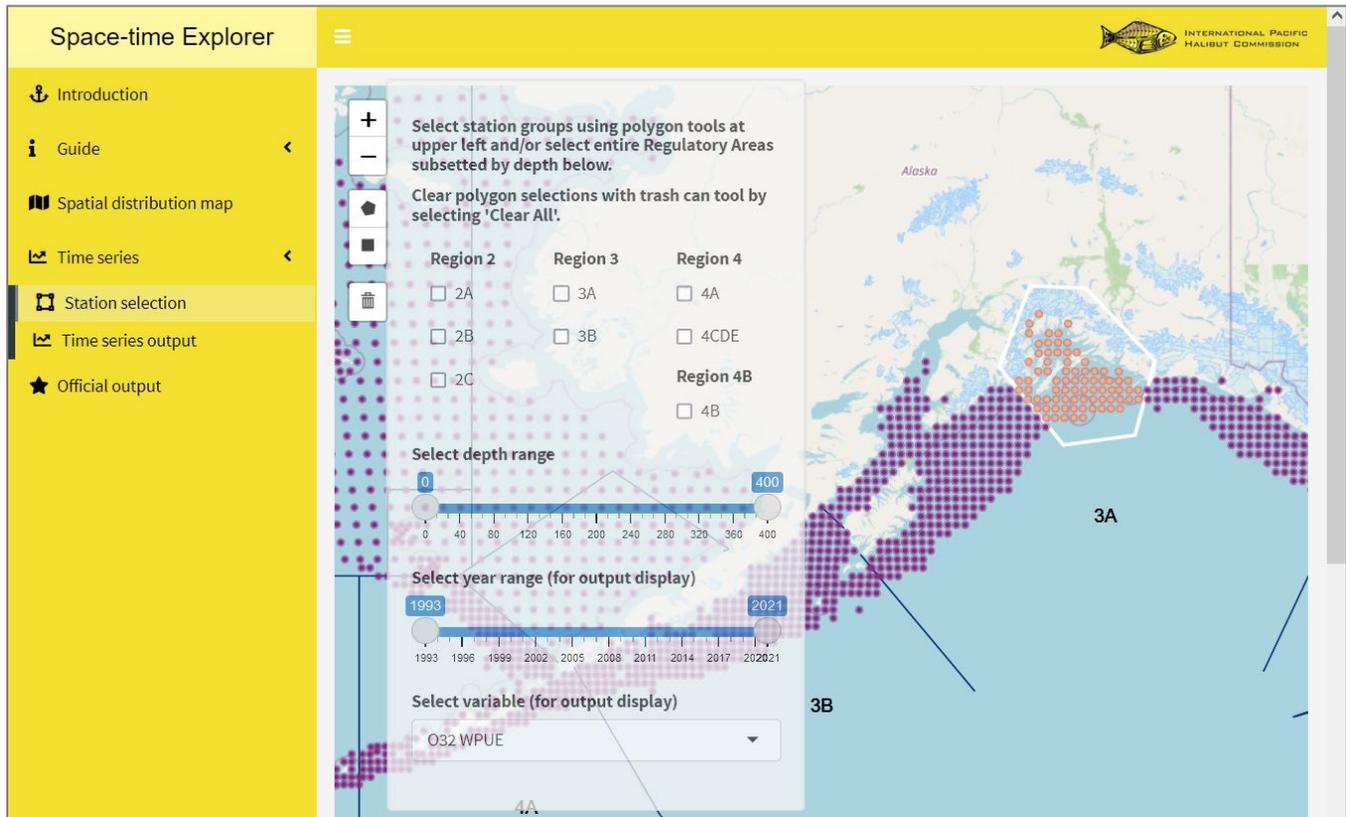
### ***Time series output***

The output resulting from the selections made in the **Station selection** tab is shown in the **Time series output** tab. Depending on the number of stations selected, it may take several seconds of processing time before the output appears. Processing progress is tracked by the bar at lower right of the screen.

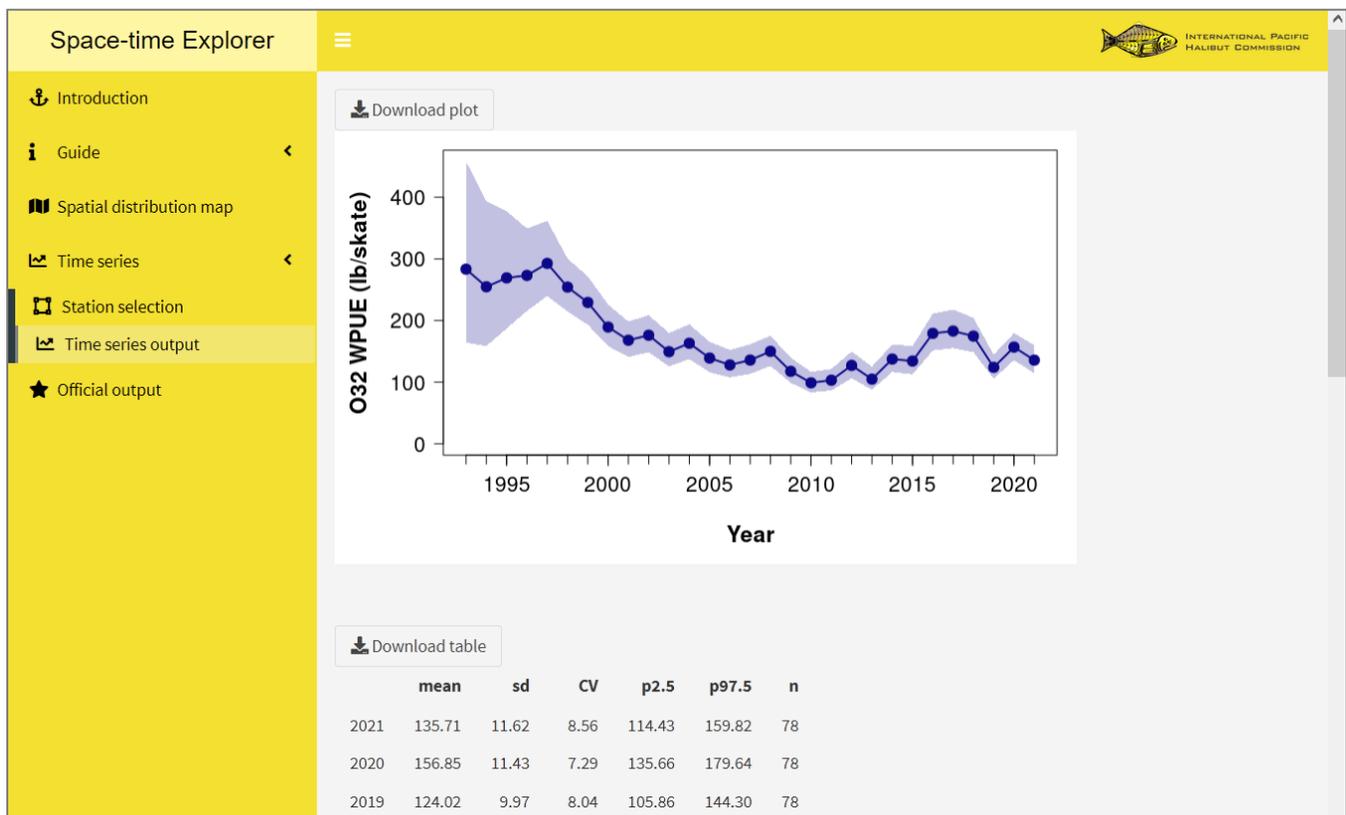
*Time series plot:* The plot shows the estimated mean of WPUE or NPUE over the selected stations for each year as a solid circle, with lines connecting the circles to help make the trend easier to see. Variability ("uncertainty") in the estimates is shown with shaded regions representing 95% posterior credible intervals: there is a 95% chance the true mean for a year is within the shaded region, and thus wider shaded regions represent more variability/greater uncertainty/less precision.

*Time series table:* The data in the plot are also presented in tabular form, along with the CV (%) and the number of stations included in the selection (n). The latter is not the same as the number of stations fished each year – it simply represents the size of the selection and makes no adjustment for different station densities in the Bering Sea and northern IPHC Regulatory Area 2A. The columns p2.5 and p97.5 give the upper and lower limits of the 95% intervals, i.e., the limits of the shaded regions in the plot.

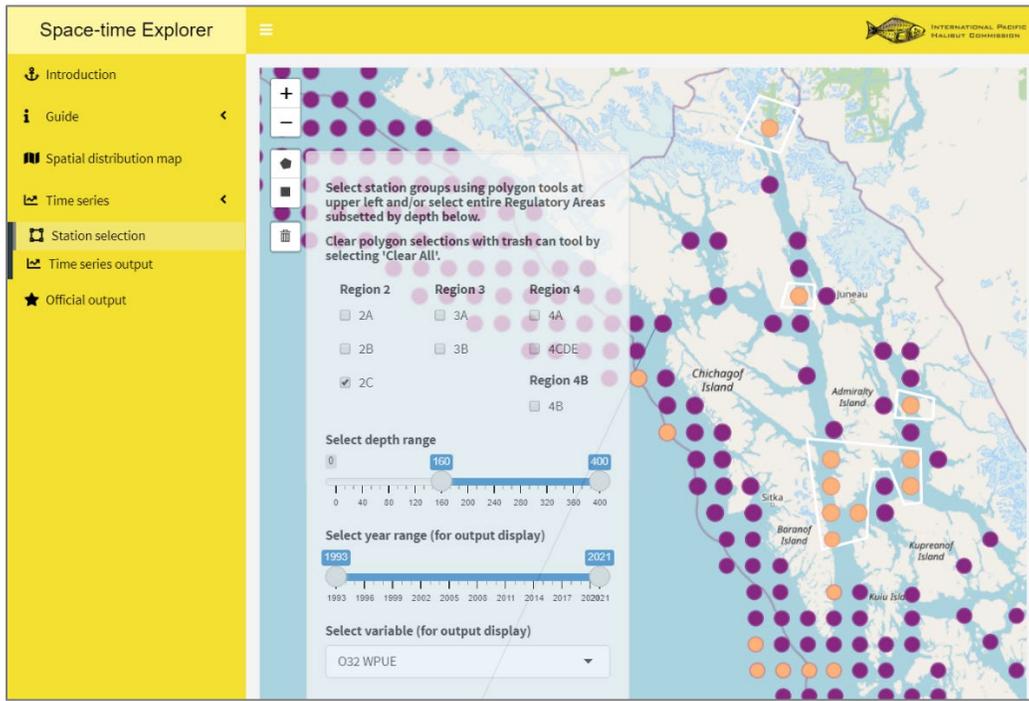
Both the plot and the table may be downloaded as png and csv files respectively. Users can create their own plots using the data in the downloaded table files. For example, the user may wish to compare time series for multiple selections in a single figure, something the Space-time Explorer Tool does not do at present.



**Figure 4.** The **Station selection** page from the **Time series** drop-down tab, showing the stations around Prince William Sound selected using the polygon selection tool at upper left.



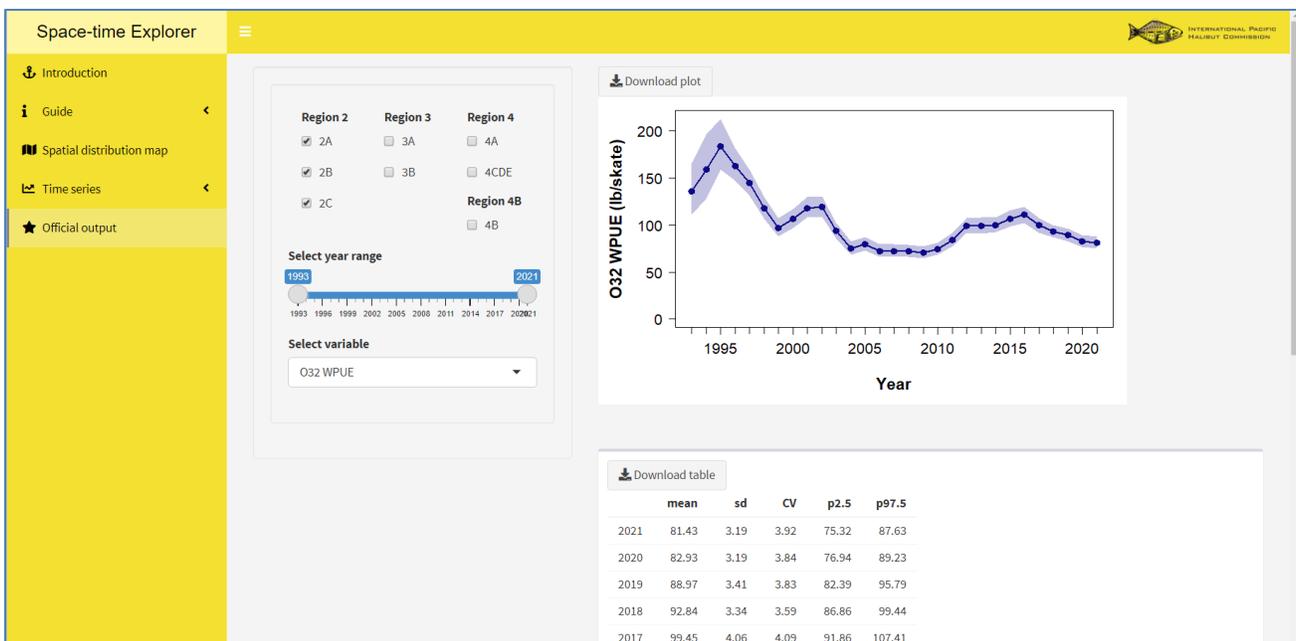
**Figure 5.** The **Time series output** page of the **Time series** drop-down tab, showing the output for the stations selected in Figure 4.



**Figure 6.** Example of a polygon selection for a limited depth range. Here the user is interested in trends in deeper inside waters ( $\geq 160$  fathoms, as selected by slider) in northern IPHC Regulatory Area 2C. The final step would be to uncheck the 2C check box, leaving only the stations within the polygons selected.

### Official output

The **Time series** tab output for combined IPHC Regulatory Areas (e.g., grouping areas into Biological Regions) can differ slightly from the output published annually by the IPHC in documents and presentations – see the **Guide** tabs for details. For this reason, a tab with published IPHC space-time model output for IPHC Regulatory Areas (**Official output**) is included with the Space-time Explorer tool. As with the Time Series tab, IPHC Regulatory Areas can be combined (e.g., into Biological Regions) by checking the boxes for multiple areas ([Figure 7](#)).



**Figure 7.** The **Official output** tab from the Space-time Explorer tool, showing results for O32 WPUE in Biological Region 2 created by selecting the check boxes for IPHC Regulatory Areas 2A, 2B and 2C.

**UPDATE SCHEDULE**

The modelling required to produce the input data for the Space-Time Explorer tool is typically completed by mid-November each year. We expect the tool to be updated annually with the most recent year's data by early December. Improvements and fixes to the tool may occur throughout the year.

**REFERENCES**

- Ualesi, K., Wilson, D., Jones, C. Rillera, R. and Jack, T. IPHC Fishery-independent setline survey (FISS) design and implementation in 2021. IPHC-2022-AM098-07.
- Webster, R. A., Soderlund, E., Dykstra, C. L., and Stewart, I. J. 2020. Monitoring change in a dynamic environment: spatio-temporal modelling of calibrated data from different types of fisheries surveys of Pacific halibut. *Canadian Journal of Fisheries and Aquatic Sciences* 77: 1421-1432. doi.org:10.1139/cjfas-2019-0240
- Webster, R. A. 2021. 2022-24 FISS design evaluation. IPHC-2021-SRB018-05 Rev\_1.