dive_parameter_analysis.py User Guide

User Guide for Dive Detection, Dive Parameter Extraction, and VeDBA-based Diagnostic Output

Purpose. This script detects dives from depth time-series data, extracts standard dive parameters, and calculates VeDBA-based locomotor effort metrics from two selected acceleration axes. It also exports diagnostic plots that allow the detection results and the relationships among dive performance variables to be checked visually.

1. Overview

• The script is intended for biologging datasets that contain at least time, depth, temperature, and two acceleration columns. It is particularly useful for exploratory analyses of diving behaviour because it links dive detection, summary statistics, and VeDBA-derived effort indices within a single workflow.

• The recommended workflow is simple: run the script with the default acceleration-axis selection when the standard longitudinal and dorso-ventral columns are available, enter a biologically appropriate depth threshold and minimum dive duration, and then inspect the overview plot, histograms, and scatter plots together before proceeding to formal statistical analysis.2. Expected Input

Required columns: time, depth, temperature

Acceleration columns: any two available axes among acceleration_longitudinal, acceleration_dorso_ventral, acceleration_lateral, acceleration_x, acceleration_y, and acceleration_z

3. Input Parameters

Prompt	Default	Use in most cases	Adjust when...
Enter the dive data filename	—	Enter the target CSV file. The .csv extension may be omitted.	Only if the file is stored under a different name or path.
Time difference between UTC and local time	+9	Use +9 for Japan Standard Time.	Change only when the deployment should be interpreted in another local time zone.
Two acceleration axes used for VeDBA calculation	acceleration_longitudinal and acceleration_dorso_ventral (if available)	Use the default pair when the standard longitudinal and dorso-ventral columns are present.	Select another pair when the logger or exported CSV uses x/y/z naming or lacks the default columns.
Depth threshold used to define dive start and end	No fixed default; user defined	Choose a threshold that separates true dives from near-surface noise.	Raise the threshold if surface noise generates false dives; lower it if biologically meaningful shallow dives are being missed.

Minimum dive duration	No fixed default; user defined	Choose the shortest duration still consistent with a true dive event.	Increase it to exclude brief threshold crossings caused by noise, or decrease it if short but valid dives are expected.
Histogram bin size for dive duration	1 s	Use the default for small to moderate datasets.	Increase for broader summaries or decrease for finer resolution when enough dives are available.
Histogram bin size for dive depth	0.4 m	Use the default for routine inspection of depth distributions.	Decrease if fine-scale variation in shallow depths is important, or increase if the histogram is too noisy.

4. Example Run

python dive_parameter_analysis.py

Enter the dive data filename (the .csv extension may be omitted): 9A96021_W190-D2GT_36_20050830_standardize

Enter the time difference between UTC and local time (e.g. Tokyo = +9) (blank = +9):

--- Acceleration columns ---

Available: acceleration_longitudinal, acceleration_dorso_ventral

Enter the two acceleration axes to use for VeDBA calculation

(e.g. acceleration_longitudinal acceleration_dorso_ventral / acceleration_y acceleration_z)

Blank = acceleration_longitudinal acceleration_dorso_ventral:

Two axes used for VeDBA: acceleration_longitudinal, acceleration_dorso_ventral

Enter the depth threshold (m) used to define dive start and end: 0.2

Enter the minimum dive duration (s): 2

Saved: 9A96021_W190-D2GT_36_20050830_standardize_dive_parameters.csv

Number of detected dives: 7

--- Summary statistics (also saved to CSV) ---

[dive_duration_sec]

 n   : 7

 min : 3.000

 max : 12.000

 mean : 5.857

 median : 5.000

 sd   : 3.185

[max_depth_m]
 n   : 7
 min : 0.606
 max : 5.932
 mean : 2.220
 median : 1.048
 sd   : 2.007

[dive_duration_to_max_depth_sec]
 n   : 7
 min : 0.000
 max : 6.000
 mean : 2.000
 median : 1.000
 sd   : 2.000

[dive_duration_from_max_depth_sec]
 n   : 7
 min : 2.000
 max : 6.000
 mean : 3.857
 median : 3.000
 sd   : 1.574

[bottom_dur_sec]
 n   : 7
 min : 0.000
 max : 3.000
 mean : 1.571
 median : 1.000
 sd   : 1.134

[number_bottom_ascents]
 n   : 7
 min : 0.000
 max : 2.000
 mean : 0.857
 median : 1.000
 sd   : 0.690

Saved: 9A96021_W190-D2GT_36_20050830_standardize_dive_stats.csv
Enter the histogram bin size for dive duration (s) (blank = 1):
Enter the histogram bin size for dive depth (m) (blank = 0.4):

Figures saved: 9A96021_W190-D2GT_36_20050830_standardize_overview_profile_plot.png,
9A96021_W190-D2GT_36_20050830_standardize_dive_histograms.png

Saved CSV with VeDBA and additional parameters: 9A96021_W190-
D2GT_36_20050830_standardize_dive_parameters.csv
Scatter plot figure saved: 9A96021_W190-D2GT_36_20050830_standardize_dive_scatter_plots.png

5. Output Files

*_dive_parameters.csv Main dive-by-dive output including timing, depth metrics, bottom-phase
descriptors, sample counts, and VeDBA-derived variables.

*_dive_stats.csv Summary statistics for the main dive parameters.

*_overview_profile_plot.png Combined time-series figure showing depth, temperature, and acceleration.

*_dive_histograms.png Histograms of dive duration and maximum depth.

*_dive_scatter_plots.png Scatter plots summarizing relationships among dive performance and effort
metrics.

6. Reading the Output Figures

Figure 1: Overview profile plot

This figure shows depth, temperature, and the selected acceleration axes through time on a common local-
time axis. It is the first diagnostic to inspect because it allows the user to confirm that the chosen depth
threshold captures the intended dives and that periods of submergence correspond to plausible
acceleration signals. In the present example, seven dives are visible as clear downward excursions in the
depth trace, and the corresponding acceleration records indicate that body movement increased during
dive periods.

Figure 2: Histograms of dive duration and maximum depth

These histograms summarize the distribution of dive performance in the detected set of dives. They are
useful for identifying whether the threshold settings produce an unrealistically large number of extremely
short or extremely shallow events. In this example, the small sample size is obvious, but the histograms still
show that most dives were relatively short and shallow, with one deeper event reaching nearly 6 m.

Figure 3: Scatter plots of dive performance and VeDBA-based metrics

These scatter plots provide an exploratory view of the relationships among dive duration, maximum depth,
mean VeDBA, cumulative VeDBA, and cost per metre. They are particularly useful before formal modelling
because they show whether effort tends to scale with dive duration or depth and whether deeper dives
appear relatively more or less costly. In the present example, maximum depth increases broadly with dive
duration, and the derived effort indices can be compared directly across dives.

7. Interpretation of the Present Example

For this file, the settings used in the example detected seven dives deeper than 0.2 m and longer than 2 s. The output is internally consistent: the overview plot shows distinct dive events, the summary statistics describe a set of mostly shallow dives with one markedly deeper event, and the scatter plots provide a reasonable exploratory basis for evaluating relationships among dive depth, dive duration, and locomotor effort. This example therefore illustrates a successful basic workflow for dive detection and parameter extraction prior to downstream statistical analysis.

8. Practical Notes

• Dive detection is sensitive to the depth threshold and minimum dive duration; both parameters should be chosen with reference to sensor noise and the expected behaviour of the study species.

• If the standard acceleration column names are absent, the script can still calculate VeDBA from any two available axes, provided that they are specified at the prompt.

• The overview plot should always be checked before interpreting the numerical outputs, because inappropriate threshold values can generate biologically implausible dive detections.

• The scatter plots are intended for exploratory interpretation and should be complemented by formal statistical analysis when drawing biological conclusions.

Example Output Figures

These figures (Figs 1–3) show an example of the dive detection, parameter extraction, and VeDBA-based exploratory workflow applied to a Streaked Shearwater dataset.
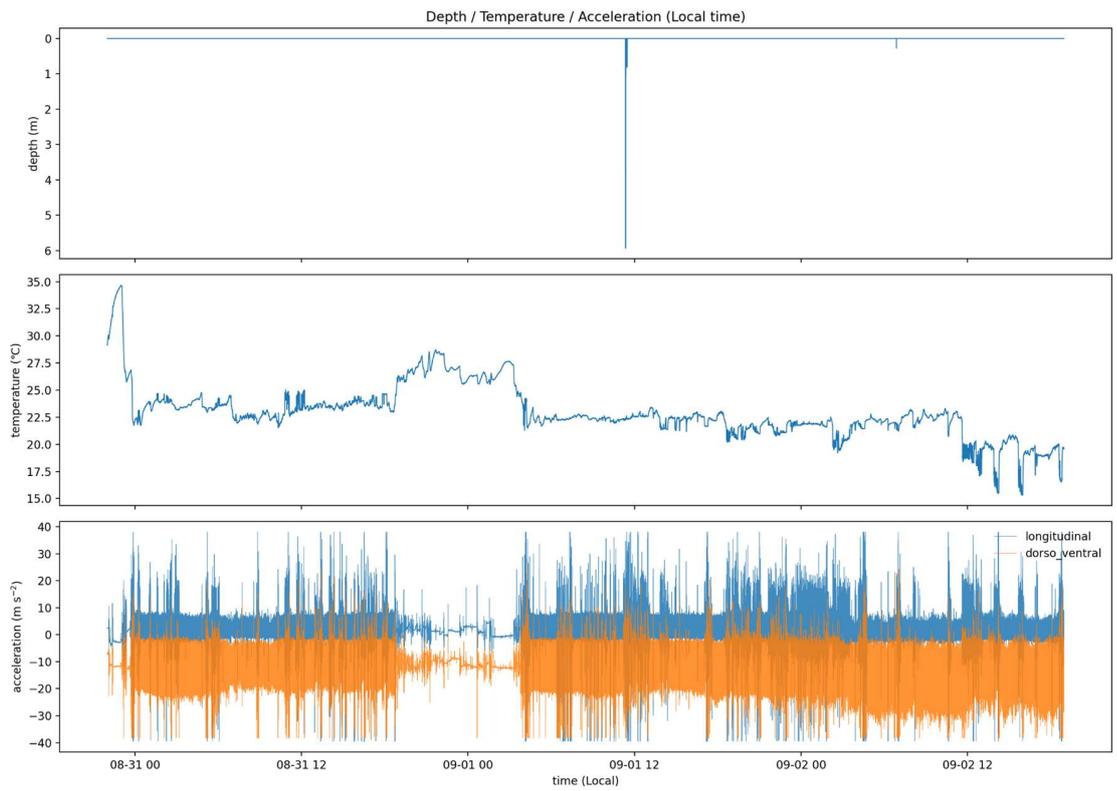
Fig. 1. Overview profile plot from dive_parameter_analysis.py. The upper panel shows depth, the middle panel shows temperature, and the lower panel shows the selected acceleration axes. This figure is used to verify that detected dive periods correspond to plausible changes in depth and body movement.
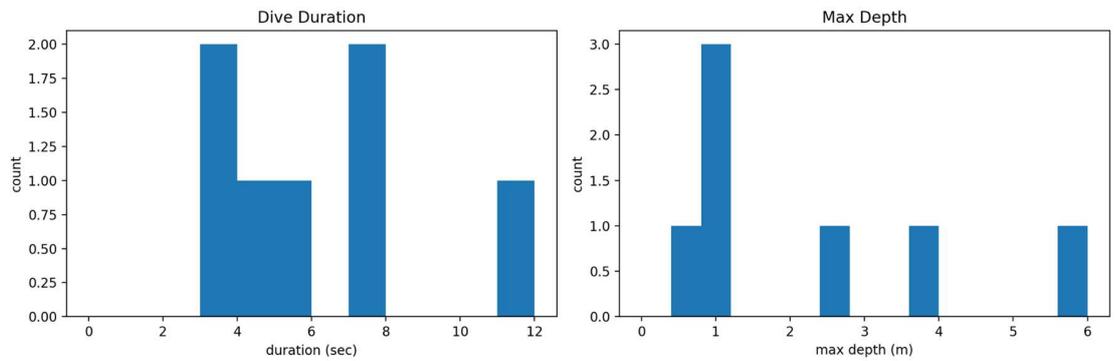

Fig. 2. Histograms of dive duration and maximum depth for the detected dives. These panels summarize the frequency distribution of basic dive performance variables and help identify unusually long or deep events.
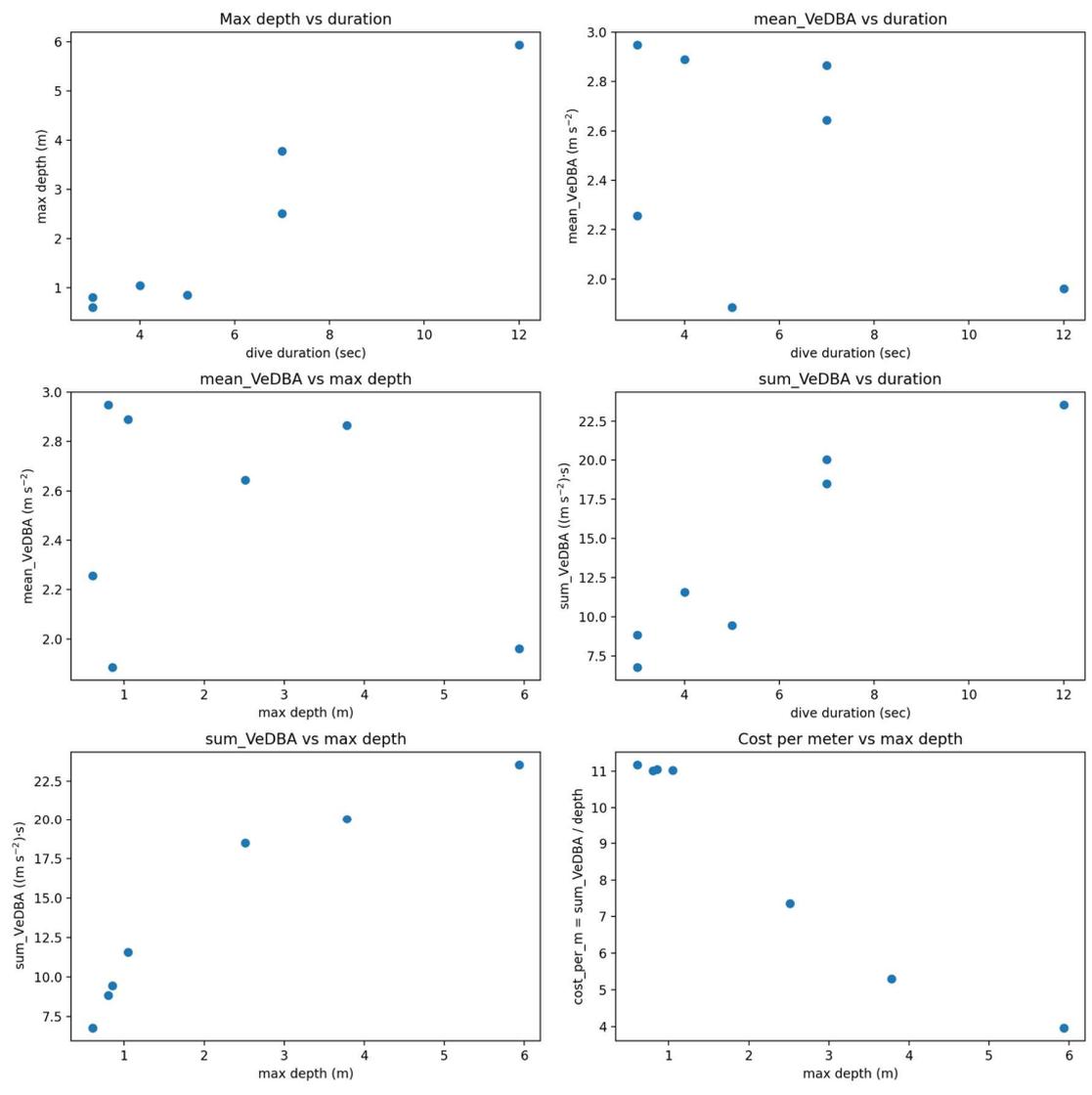
Fig. 3. Scatter plots summarizing relationships among dive performance and VeDBA-based metrics. These exploratory plots allow comparison of dive duration, maximum depth, mean VeDBA, cumulative VeDBA, and cost per metre across dives.