Using SST and Vertical Water Profiles to Identify a Safe Artificial Upwelling Depth

Problem:
Marine Heatwaves are increasing.
Artificial upwelling can cool surface waters.
However,
Deep water may contain low oxygen.

Haruo Fujimoto
NPO ESCOT, Japan

Analysis of Ise Bay

observations (2024-2025) showed:

5 m depth provides the best balance between

- Cooling effect
- Dissolved Oxygen
- Ecosystem safety

Healthy Cooling Water Layer (~5m)
Ise Bay July 2025 Average

Figure 1. Physical Environment
Temperature, DO and Salinity

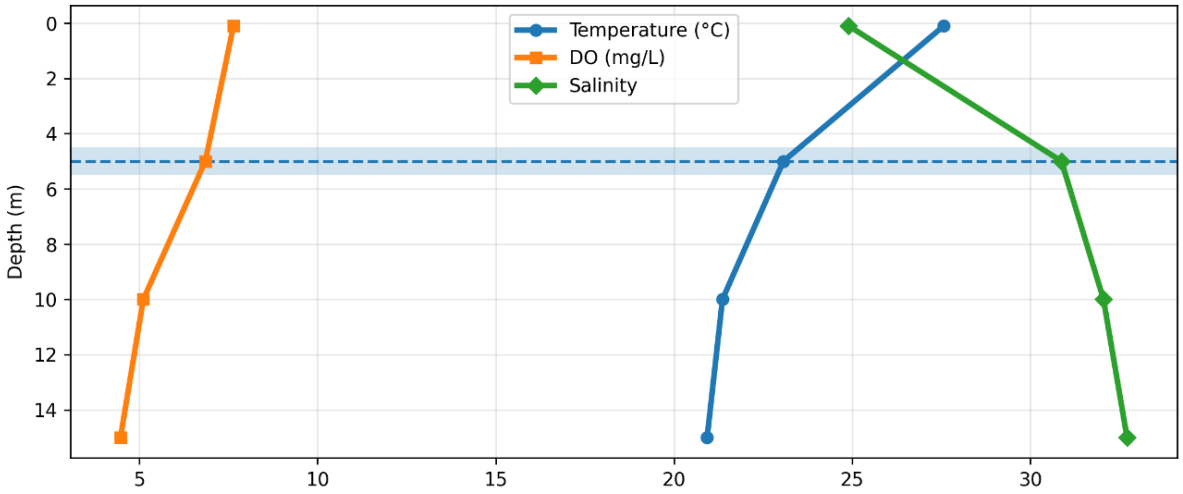
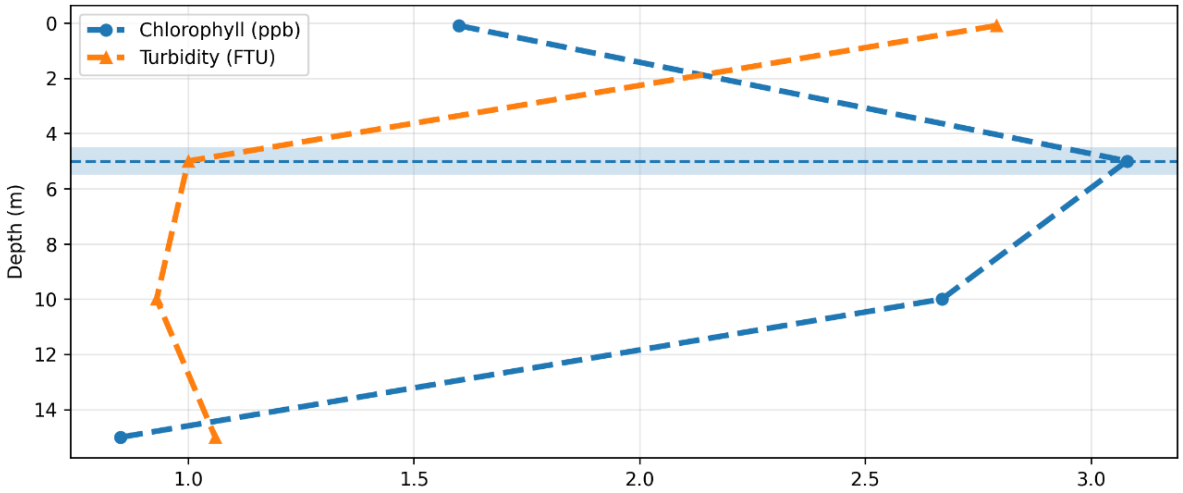


Figure 2. Biological Environment
Chlorophyll and Turbidity



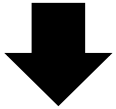
5 m layer: -4.5°C cooling, DO=6.85 mg/L, Peak Chlorophyll=3.08 ppb, Low Turbidity=1.00 FTU, Stable Salinity=30.87

Table 1. Mean Water Quality Parameters by Depth (Ise Bay, 2024–2025)

Depth	Temperature (°C)	Dissolved Oxygen (mg/L)	Chlorophyll-a (µg/L)	Salinity (PSU)	Turbidity (NTU)
0.1 m	27.57	7.64	1.60	24.90	2.79
5 m	23.07	6.85	3.08	30.87	1.00
10 m	21.36	5.11	2.67	32.05	0.93
15 m	20.93	4.47	0.85	32.71	1.06

Key Findings

- Highest temperature at surface (0.1 m)
- Peak chlorophyll-a at 5 m
- DO decreases below 10 m



- **Optimal depth ≈ 5 m**

Main Result

Safe Cooling Depth ≈ 5 m

* Based on temperature, dissolved oxygen, and biological productivity.

Ecological risk reduction:

70–80%

compared with deeper upwelling.

Take Home Message

Not all cold water is beneficial.
The optimal target is a
Healthy Cooling Water Layer
that combines:

- lower temperature
- sufficient oxygen
- ecological safety

Healthy Cooling Water Layer:
A new concept for safe and sustainable artificial upwelling under climate change.

Healthy Cooling Water Layer

A new concept for safe and sustainable artificial upwelling

- Cooler water
- Adequate oxygen
- Ecosystem safety

Recommended Upwelling Depth in Ise Bay: ~5 m

Applicable to coastal waters affected by marine heatwaves worldwide.