

How noisy is the largest natural deep lake in France?

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Context

- Growing interest in **acoustic pollution** for its **social issues** and non-negligible but understudied **ecological impacts**
- Mainly focused on terrestrial and marine systems, in freshwater **lack of spatio-temporal evaluation** of human-made noise



Perception of noise pollution by lake users

- 25% highlight problems related to noise pollution
- 23% have proposed improvements that would help to reduce it

Objective of the project : **POLLUSON** aims to give **baseline and variation of noise levels in a large lake**



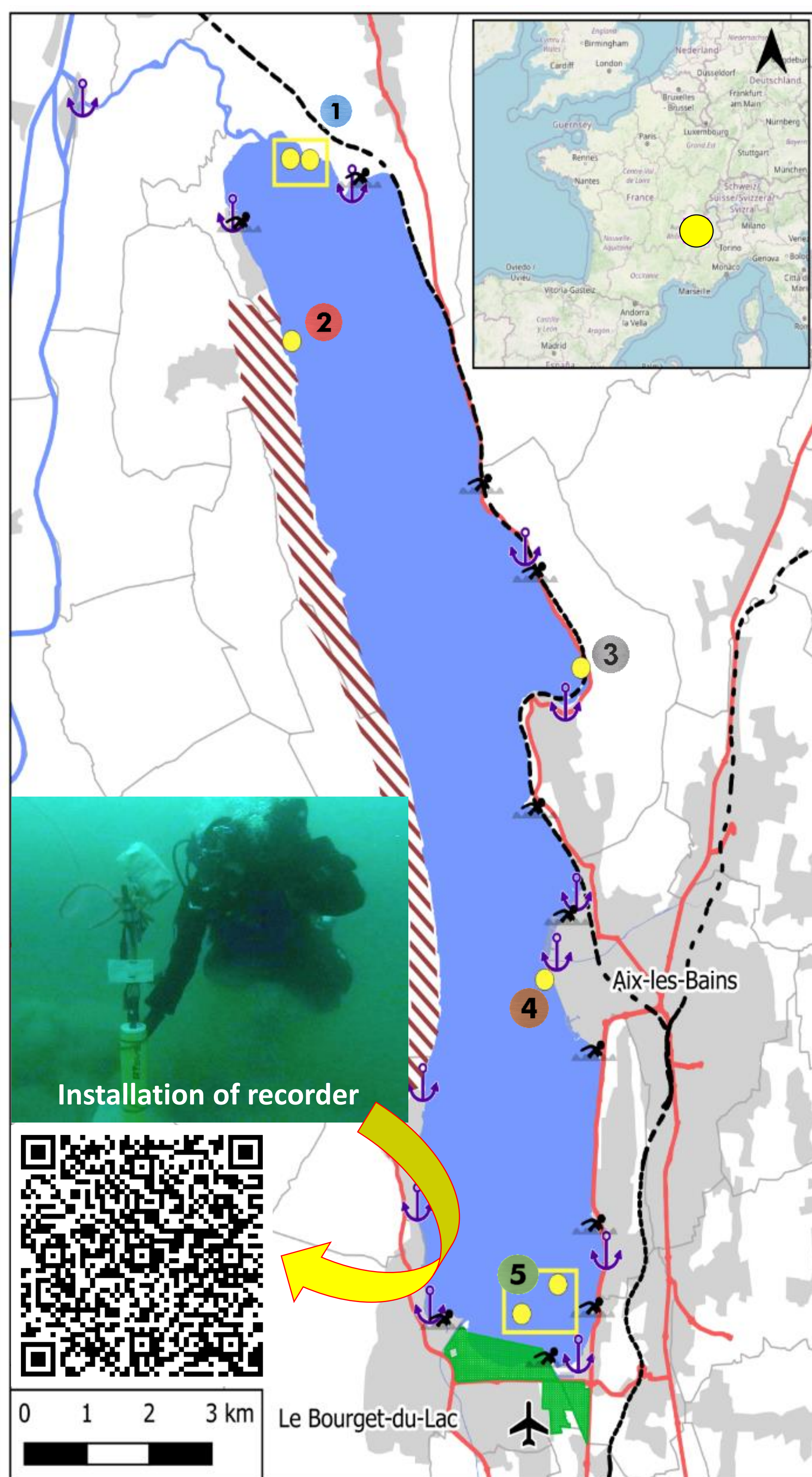
Method

- 5 sites reflecting the diversity of noise pollution
- Different durations (May 2021 → Sep 2022)
- Deployment of underwater acoustic recorders RTSYS SYLENCE-LP with Colmar GP1516 hydrophone (SH: -172, amplification factor 0dB, correction factor 1)
- Recorders information:
 - Sampling rate: 64000S/s, 16bits
 - Sampling cycle: 30min/30min
 - Depth varying between 21 and 27 meters



Scientific diving to deploy the recorders, check their functioning and collect the data every four months (~ 100 h).

- Calculate and report sound diversity and level variations



Results

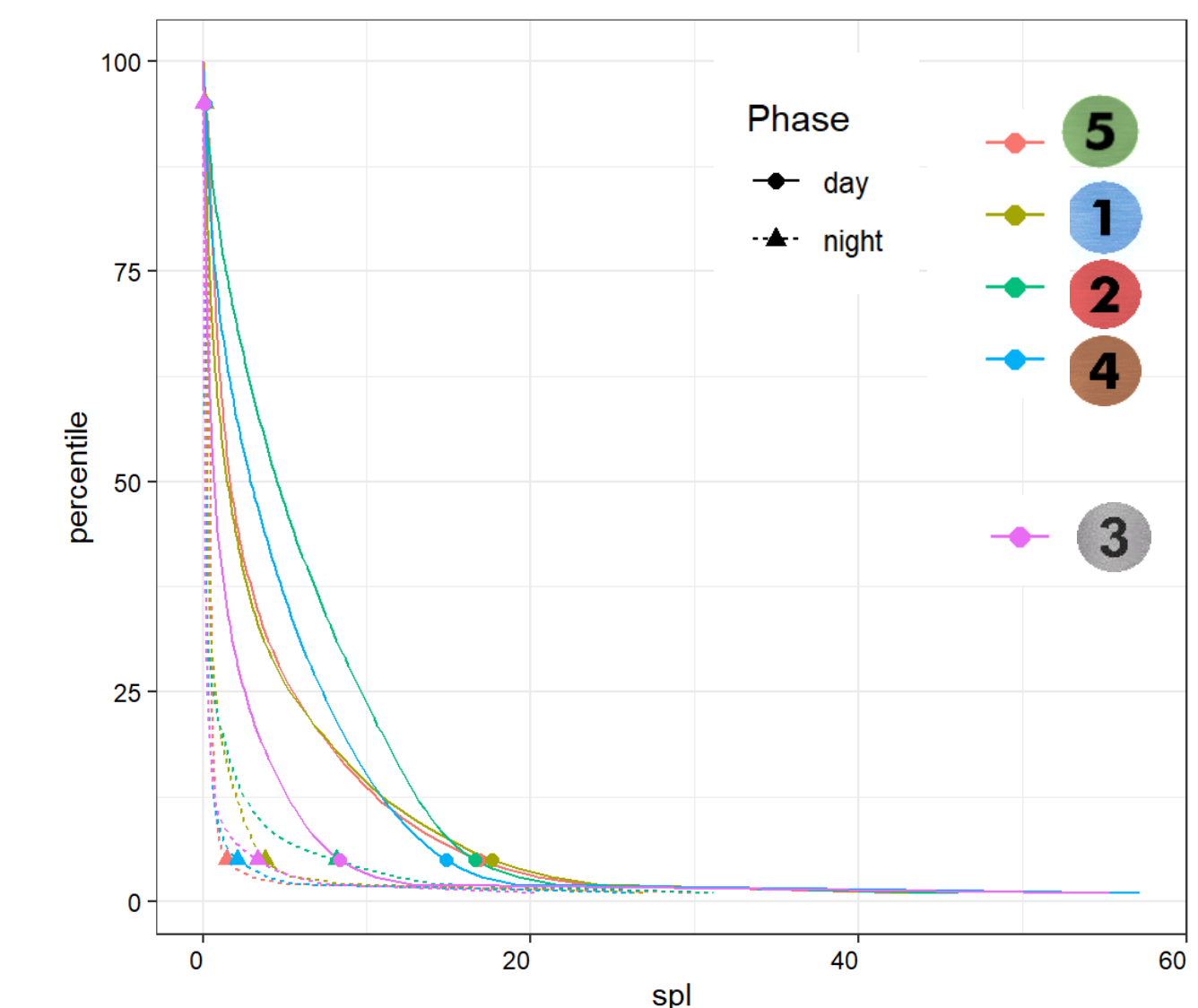
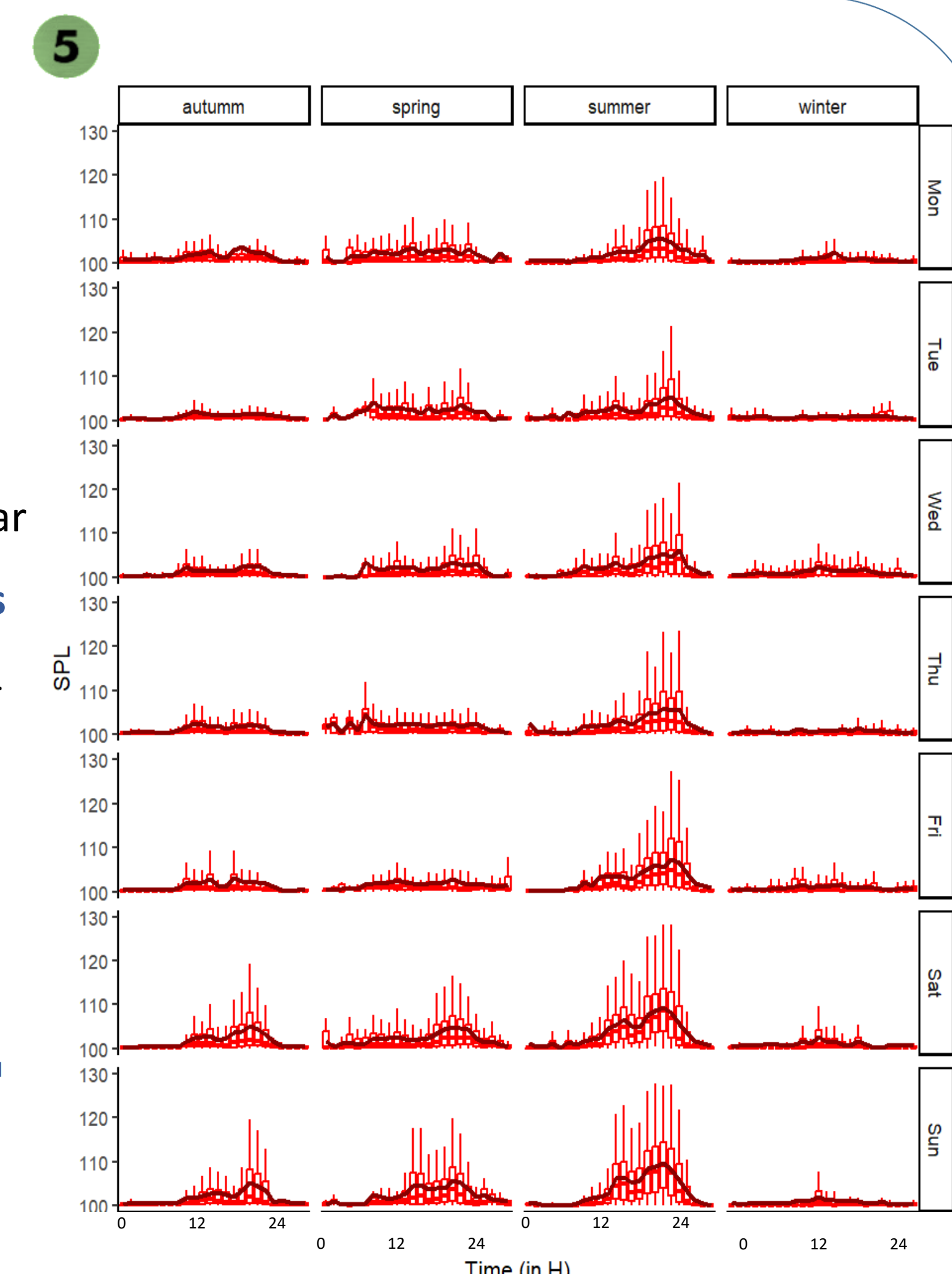
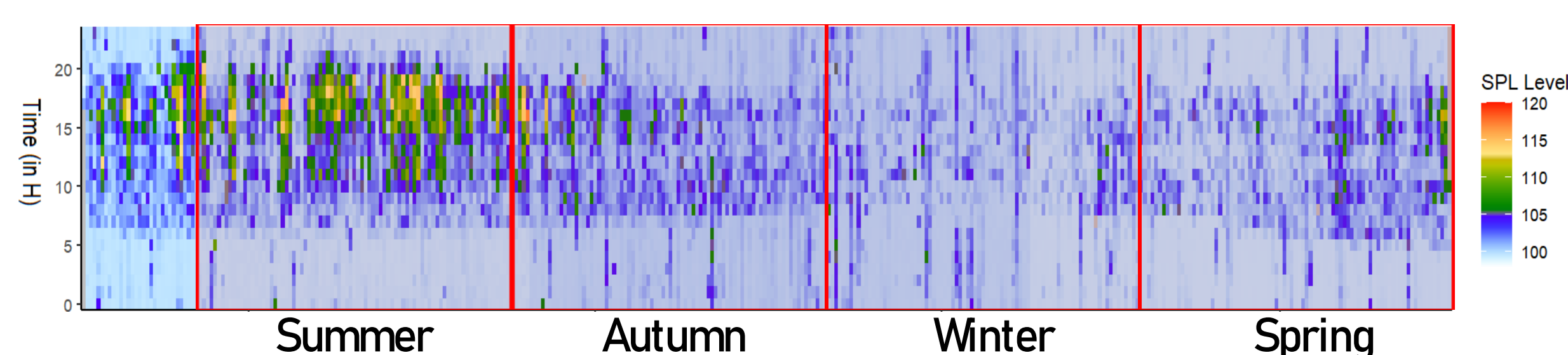
Temporal variation:

The **sound level** fluctuates strongly **depending on the seasons** and it is attributed mainly to boat noises (frequencies range from 0.1 to 12 KHz).

Winter: **no difference** in the average level noise compared to **background noise**, stay around 100 dB.

Summer: **Sharp increase in noise levels during the day phase** and in particular at the end of the afternoon. **No difference between weekend and the others days of the week.** On average, the increase in sound level per day is around 4 dB with **average increases per hour of up to 10 dB.**

Autumn & spring: little noise during the week but **an increase in the level during the weekends**, same daily scheme.



Spatial variation:

Spot 3 records **lower overall sounds** with big differences in **Top 5%** with start at **+10 dB augmentation** of noise level

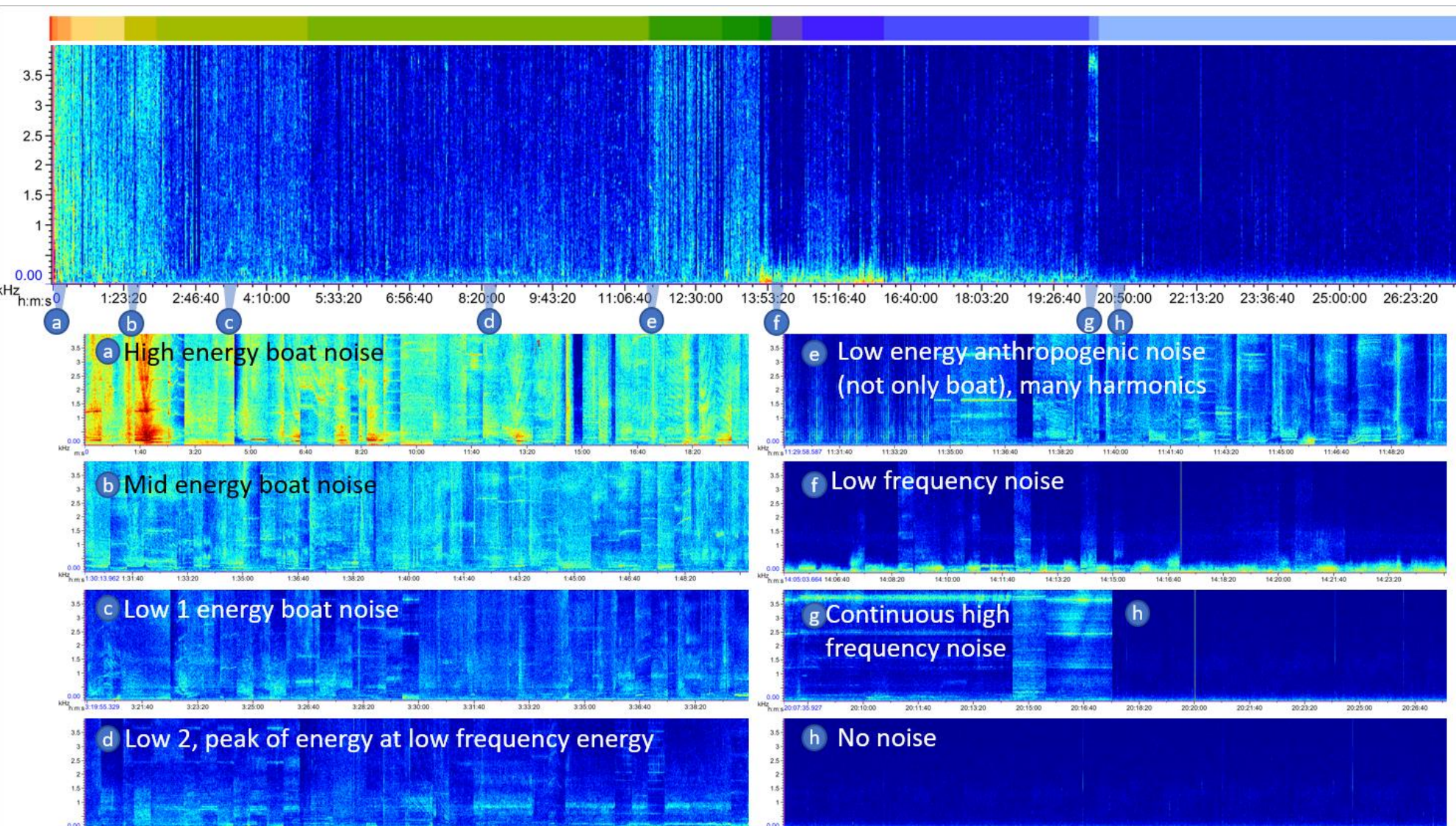
All the others locations have approximately the same base levels and the **same overall sound values augmentation** with really close **Top 5%** power sounds (with start at **+18 dB augmentation** of noise level)

Diversity of anthropogenic noise & Qualification:

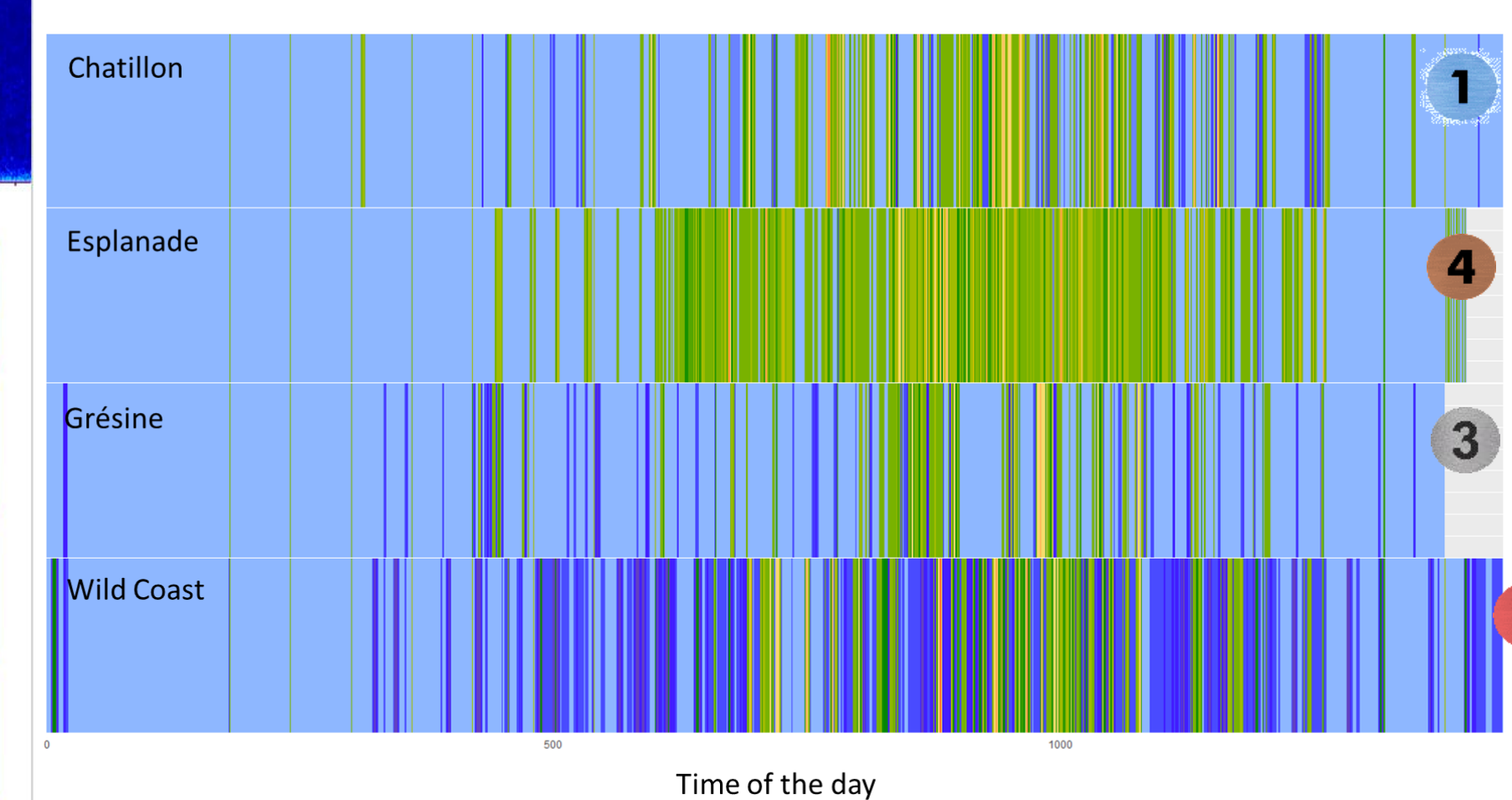
Soundscapes dominated by **High "diversity" of anthropogenic sounds**

ex: Different boats with/Without Lloyd effects, **planes**, roads and railways noises), can be defined into 8 cases

Unsupervised ML, K-mean cluster (k=20) on 1 min-averaged spectra with nFFT of 512 points, **highlighted Point 4**



Representation of clusters according to time of the day



Plane recording



Discussion

Lake Bourget (Freshwater ecosystems) have an alteration of its sonic environment **different from marine environments:**

- **Noise pollution is extremely diverse** (with sounds outside the aquatic environment such as airplanes or roads)
- **Soundscapes have same augmentation of sounds average levels during summer**
- **Noise pollution is almost ubiquitous in the large freshwater lakes** but decreases sharply in the bay spot 3, far from passage areas
- **Highly related to recreational activities and their daily and annual phenology** (especially tourist activities), far from general marine shipping scheme
- **Defined category** allows a more detailed description than simply the level which allows **another level of understanding**

Perspectives

New knowledge allows more realistic modeling and projections and requires further study to understand how it can alter the ecology of aquatic environments. We are studying these effects based on key species as part of the other studies of the Polluson project.

