Electronic Supplementary Material

Appendices to *Looking for compensation at multiple scales in a wetland bird community.* Barraquand F., Picoche C., Aluome C., Carassou L., and Feigné C.

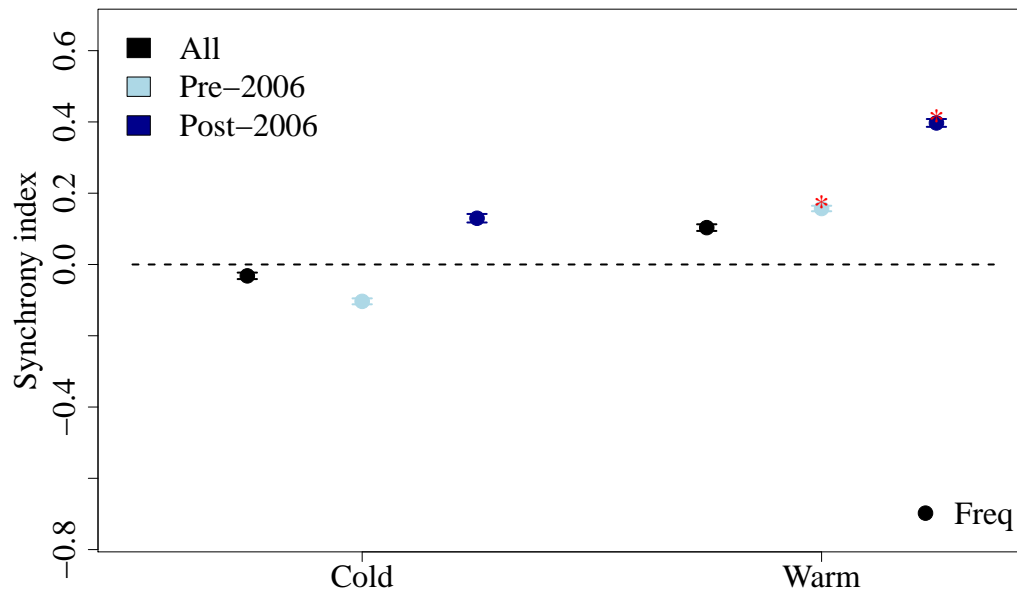## ESM 1 - Gross synchrony index at the whole community level

Figure A1: Gross' synchrony index as a function of the season (cold and warm seasons), calculated among the 60 most frequent species in the Teich reserve. The index was computed in each panel on the whole dataset (black) or using two periods: before and after 2006 (light and dark blue), the year of the change in water level management. Red stars correspond to synchrony values significantly different from the null model (independent species), at the Bonferroni-corrected 10% threshold.

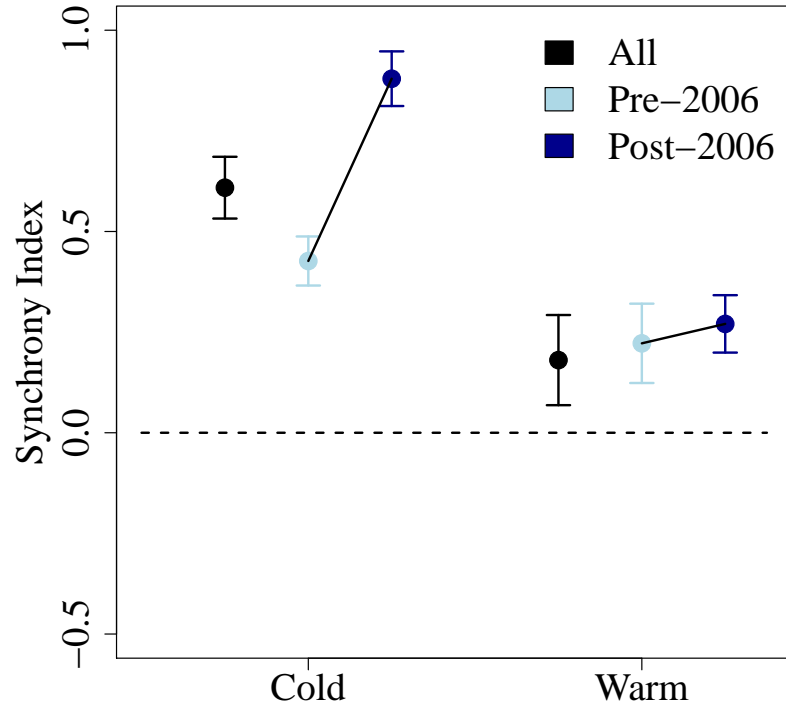**ESM 2 - Correlation in log-scale betwen cormorant and heron+egret**

Figure A2: Gross' synchrony index as a function of the season (cold and warm seasons), calculated on log-transformed abundance data for the two groups formed by cormorant and heron+egret. The index was computed in each panel on the whole dataset (black) or using two periods: before and after 2006 (light and dark blue), the year of the change in water level management.

We noted on Fig. 4 in the main text that cormorants, herons and egrets seemed to compensate each other, at least for the first period of the time series. This compensation was seen on a log scale, and seemed conspicuous on that scale. We thus wondered if log-transforming the abundance would affect the values of the synchrony index observed for this group, and make compensation more likely. It appears to be the reverse: synchrony values are higher with log-transformed abundances.

ESM 3 - Properties of the Gross whole community synchrony index when two groups react in opposite ways

Here, we make η vary with the number of species, richness of the community, and the strength of the effect of the environment. Starting from the model developped by Gross et al. [1] (developed in their Appendix D), we explored the effect of a common environmental driver on a community formed by two groups reacting oppositely to this driver.
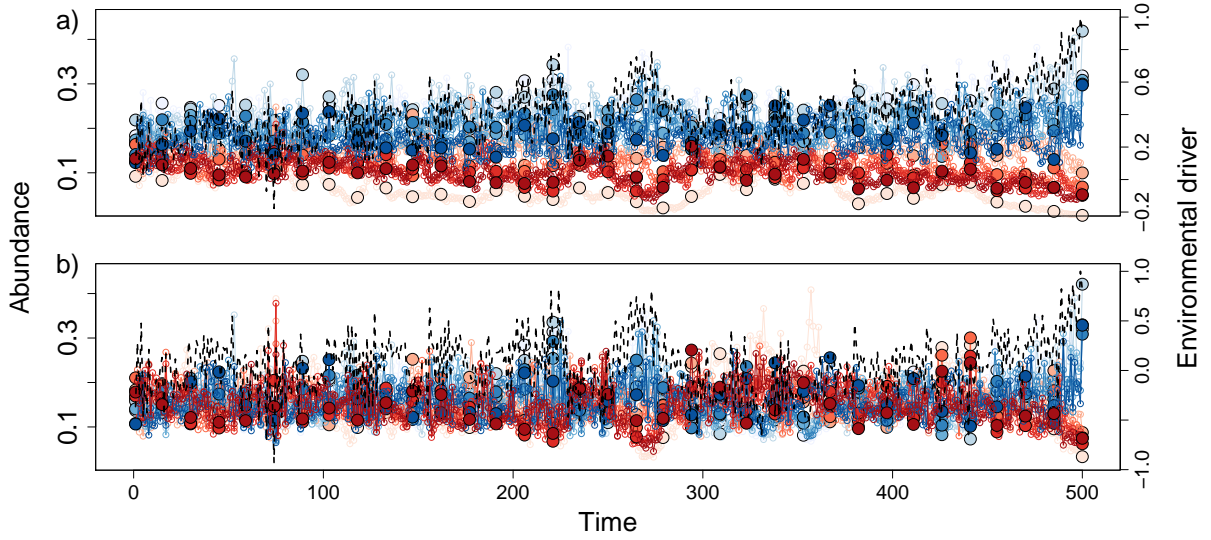

Figure A3: Time series for a community of 10 species, with a strong effect of the environment (b=0.75, see eq. 1) and a time series of 500 time steps. Open circles represent all points of the time series while large filled circles correspond to the sub-sampling of the time series (keeping only 35 points). Cold colors indicate species which react positively to the environmental signal and warm colors indicate species which have a negative reaction to the same signal. The environmental signal is shown in black, dashed lines, and indexed on the right axis. This signal either follows an increasing trend (a), or just an autocorrelated signal (b).

We assume that the environmental driver $U(t)$ is an autocorrelated signal (see below for details).

The dynamics of species i then follows the equation 1:

$$x_i(t+1) = x_i(t) \exp\left(r_i \left(1 - \frac{x_i(t) + \sum_{i \neq j}^{n} \alpha x_j(t)}{K} \right) + b_i U(t) + \epsilon_i(t) \right) \tag{1}$$

where the whole community is formed by $N = 2n$ species, with 2 groups of n species who have exactly opposite reaction to the environmental driver, that is $\forall i \in [1, n], \exists j \in [1, n], b_j = -b_i = b$. The growth rate r_i follows a normal distribution with mean 1 and standard deviation 0.25. All interaction coefficients α are set to 0.5 and $K = \frac{1 + \alpha(N-1)}{N}$, to keep the model in other ways exactly similar to Gross et al. [1]. The noise

$\epsilon_i(t)$ is normally distributed, centered on 0 with a standard deviation of 0.1.

We compared results for time series of length 35 (the length of our data set), 100 and 500. For all simulation experiments, dynamics are first run for 500 time steps as a burn-in. To take into account different observational designs, we either take the first 35 or 100 time steps of the following 500-time steps series, or subsample the time series after burn-in. We also considered several community richness (10, 30, 60 and 100 species), and several strengths of the response to the environmental signal ($b =$[0.1, 0.5, 0.75]). For each combination of parameters, we computed 10 repetitions (i.e., replicates).

We considered different types of environmental driver, crossed with subsampling / no subsampling. We considered in total three scenarios, and present below the results for all three:

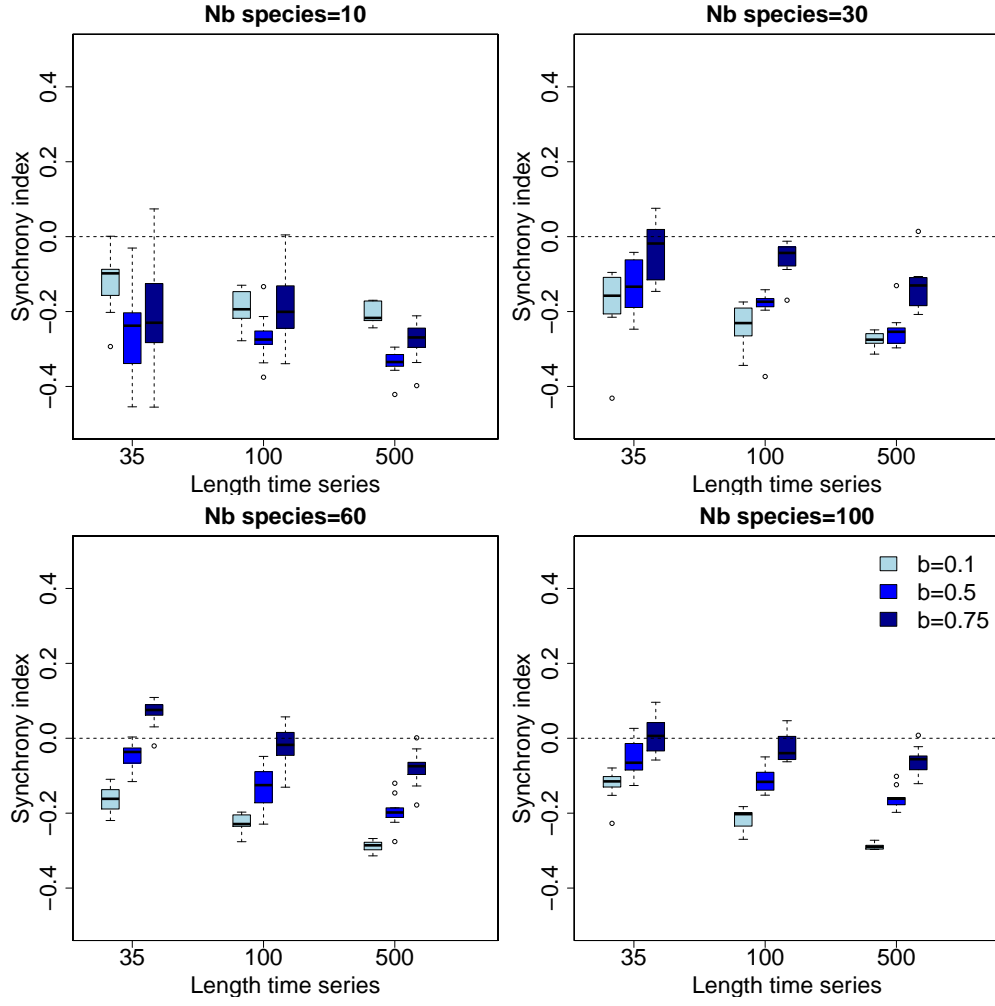- Scenario 1: $U_t = u_t$ where u_t is an autocorrelated signal (standardized); no subsampling of the data

Figure A4: Evolution of Gross' synhrony index for different time series length and number of species in the community, in simulations where there is no trend in the environmental signal and the data is not subsampled, keeping the autocorrelation of the environment.
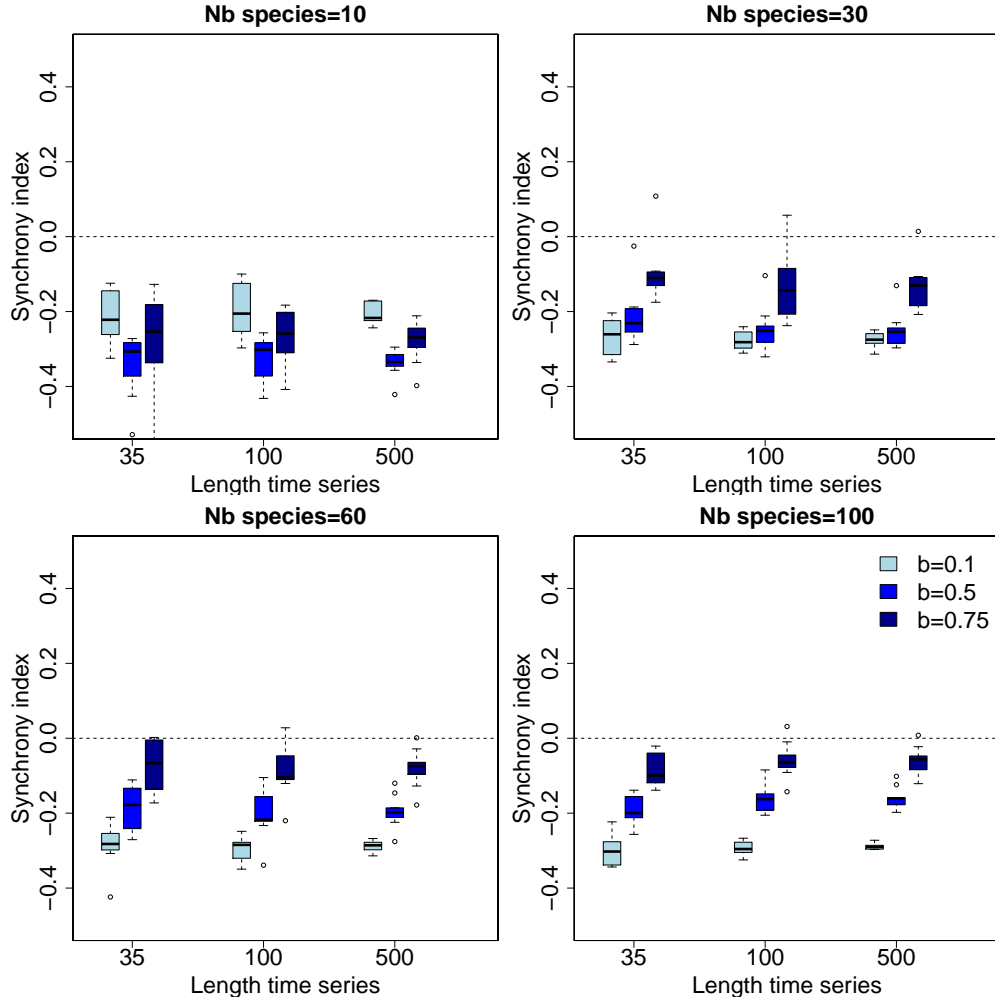
- Scenario 2: $U_t = u_t$; data subsampling

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Figure A5: Gross' synchrony index for different time series length and number of species in the community, in simulations where there is no trend in the environmental signal and the data is subsampled (keeping 35 or 100 time steps), removing in effect the autocorrelation of the environment.

- Scenario 3: $U_t = U_{\min} + (U_{\max} - U_{\min})(u_t + x_t)/2$ where $x_t \in [0, 1]$ follows an increasing trend; data subsampling
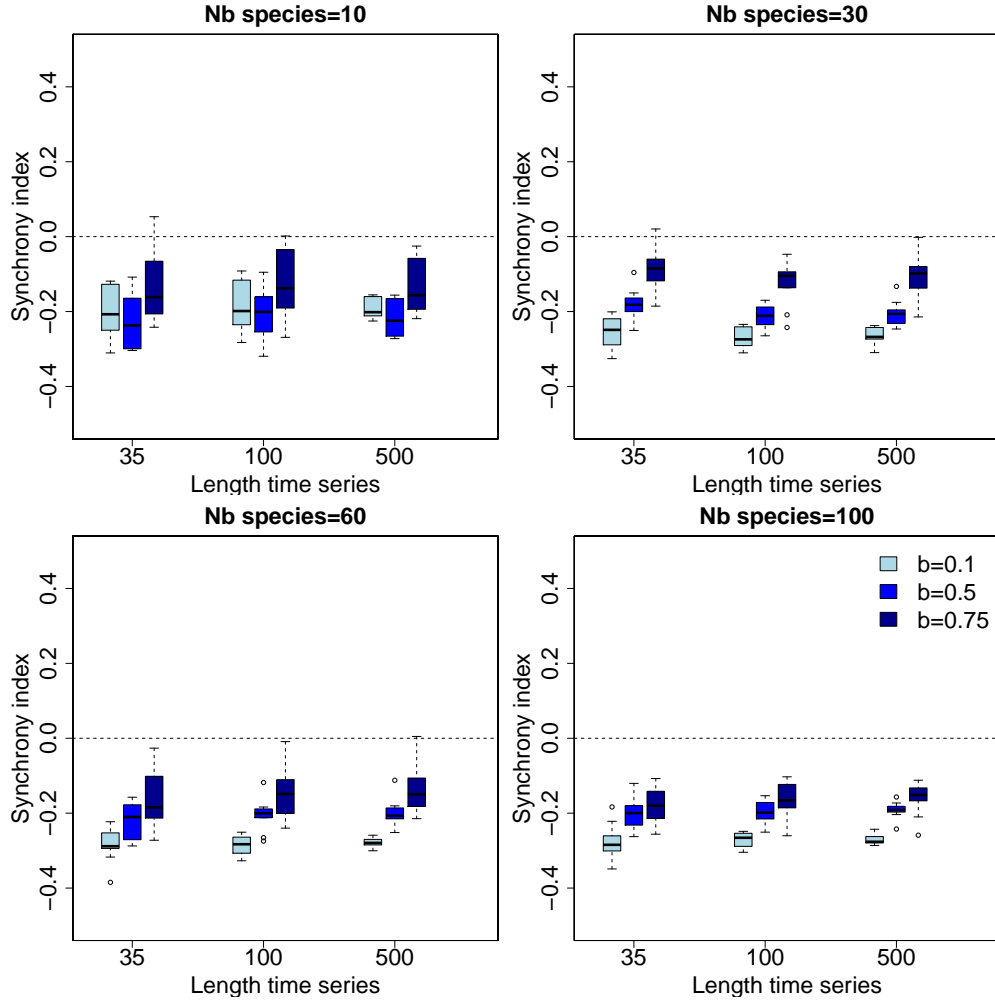
Figure A6: Gross' synchrony index for different time series length and number of species in the community, in simulations where there is an increasing trend in the environmental signal and the data is subsampled (for 35 or 100 time steps), removing part of the autocorrelation of the environment in the dynamics of the species

We first confirm that unless there is a high autocorrelation in the driver (as in Fig. A4), if we consider two groups which have opposite reactions to the same driver, the Gross index is not sensitive to the length of the time series or to the number of species in the community. For larger communities (over 10 species), synchrony is higher when the response to the driver is stronger. For our data, this means that the more birds are sensitive to the water level, the less we can expect compensation at the whole community level.

ESM 4 - Temporal patterns of functional groups in the Teich bird community
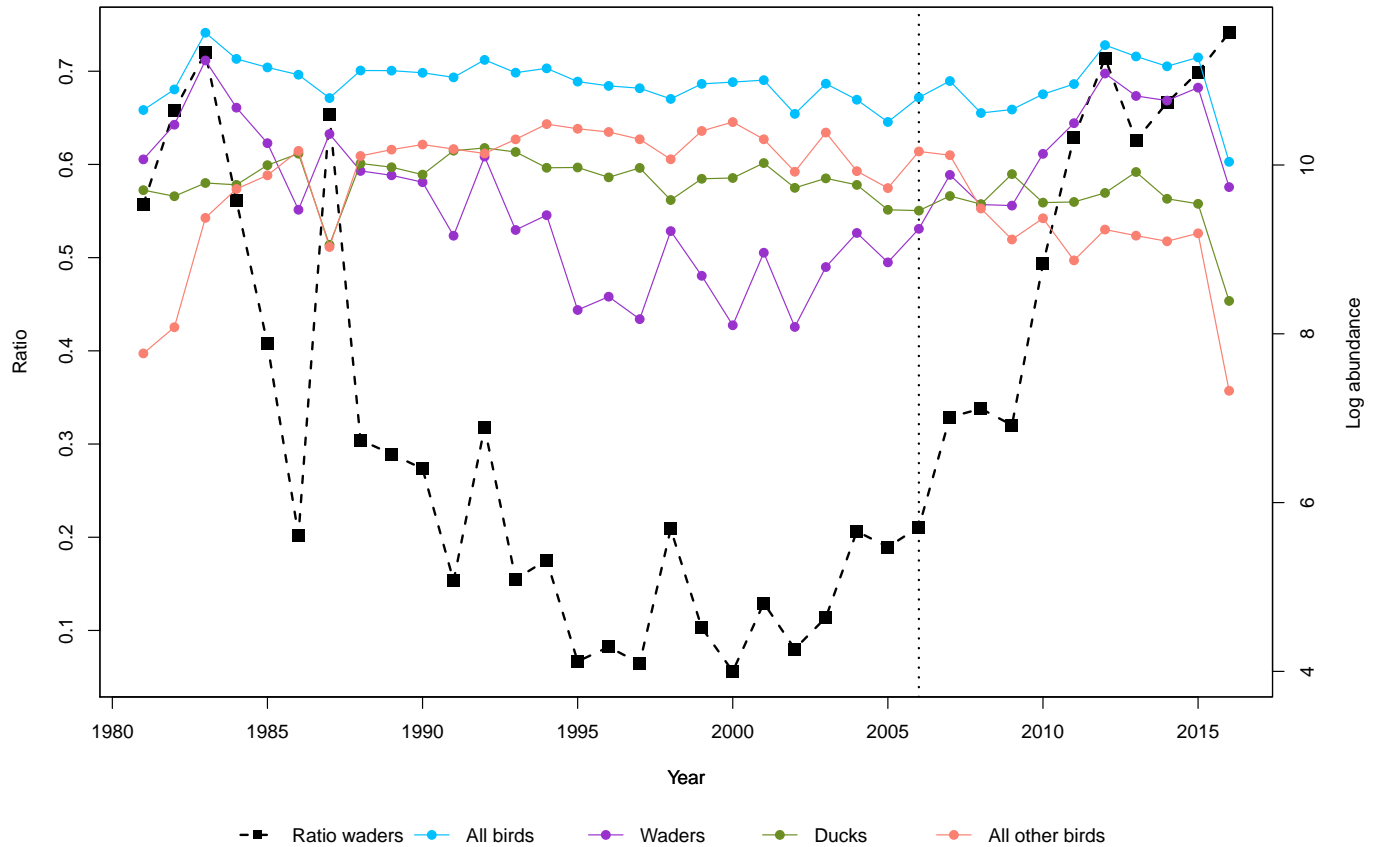

Figure A7: Temporal trends in the abundance of all birds and the main functional groups (waders and ducks). The duck category actually includes all species functionally similar to ducks (i.e., anatids and the common coot).

References

[1] Gross, K., Cardinale, B. J., Fox, J. W., Gonzalez, A., Loreau, M., Wayne Polley, H., Reich, P. B. & van Ruijven, J., 2013 Species richness and the temporal stability of biomass production: a new analysis of recent biodiversity experiments. *The American Naturalist* **183**, 1–12.