Supporting Information. M. Hidalgo, V. Rossi, P. Monroy, E. Ser-Giacomi, E. Hernández-García, B. Guijarro, E. Massutí, F. Alemany, A. Jadaud, J.L. Perez, and P. Reglero. 2019. Accounting for ocean connectivity and hydroclimate variability in fish recruitment fluctuations within large transboundary metapopulations. *Ecological Applications*.

Appendix S1: Sensitivity analysis of connectivity metrics to critical life history parameters.

While the global sensitivity of the LFN modeling framework was already assessed (Monroy et al. 2017), the robustness of the present results is here more specifically tested for three key parameters: the duration of the Pelagic Larval Duration (PLD), the number and frequency of spawning events, and the depth of dispersion. The primary factor that would affect dispersal patterns is the PLD. As such, three potential PLDs were evaluated: 30, 40 and 50 days. Note that these analyses serve also as a test to evaluate the influence of a pre-competency period of ±10 days for the settling of hake larvae. In addition, we tested the robustness of our results to more frequent spawning events by comparing periodicities of 5 and 15 days evenly distributed over the same 2-month period (September 1st to 30th November), i.e. a total of 19 and 7 (respectively) spawning events per year. Last, although hake larvae are mainly found at depths of around 90 m, suggesting it is a fair approximation of its dispersal depths (Olivar et al. 2003, Sabates, 2004), it may vary in nature. We thus assessed the robustness of our results to three different depths (60, 90 and 120 m).

Our sensitivity tests reveal that, although the absolute means of three connectivity proxies (chosen arbitrarily) slightly differ among the three tested PLDs (changes concern, in average over all years and across all diagnostics, about ±10-15% of the reference values obtained with PLDs of 40 days), their inter-annual patterns remain consistent in three distinct regions (chosen arbitrarily, Appendix S1 - Figure S1). All connectivity diagnostics in any subpopulation or management area return the same consistent inter-annual variability. The spawning frequency tests demonstrated that the annual averages of LR and SR do not differ, while minimal differences are observed in the yearly means of Imp (Appendix S1 - Figure S2). The inter-annual variability remains consistent between the two tested periodicities and the connectivity diagnostics in any subpopulations return the same robustness. While the depth of dispersal seems to be the most sensitive parameter of the three tested here, we found no consistent trend of its impact among our six subpopulations or over time. This is due to the unpredictable nature of the vertical structuring of ocean currents: in a given region and period (e.g. Gulf of Lion in winter) currents may be nearly homogeneous in the vertical (barotropic) while they may be substantially heterogeneous (baroclinic) in other regions and periods. It is also due to the fact that the surfaces of each sub-region are not comparable across the sensitivity experiments testing depth since the bathymetric mask is specific to each horizontal layer of the model. Despite these isolated small differences, non-parametric Friedman tests showed that both retention and exchange indices computed at those three depths are statistically equivalent, except in rare occasions (Appendix S1 - Tables S1 and S2).

In summary, sensitivity tests showed that the main spatial and temporal connectivity patterns are robust against small changes of LFN parameters such as PLD, periodicity of spawning and depth of dispersal. The inter-annual variability of connectivity metrics was always conserved while the mean values displayed, as expected, certain but negligible differences (apart from the specific cases sensitive to the dispersal depth). Note that the most important element in the present study is to ensure that the inter-annual fluctuations of our connectivity metrics are preserved despite slightly different parameter choices, as it was shown unambiguously for different PLDs (Appendix S1: Figure S1), frequencies of spawning (Appendix S1: Figure S2) and dispersal depths (Appendix S1: Tables S1 and S2).

References:

Monroy, P., Rossi, V., Ser-Giacomi, E., López, C. & Hernández-García, E. Sensitivity and robustness of larval connectivity diagnostics obtained from Lagrangian Flow Networks. *ICES J. Mar. Sci* .**74,** 1763–1779 (2017).

Olivar, M.P., Quilez, G. & Emelianov, M. Spatial and temporal distribution and abundance of European hake, *Merluccius merluccius*, eggs and larvae in the Catalan coast (NW Mediterranean). *Fish. Res.* **60,** 321–331 (2003).

Sabatés, A. Diel vertical distribution of fish larvae during the winter-mixing period in the North-western Mediterranean. *ICES J. Mar. Sci.* **61,** 1243–1252 (2004).

Appendix S1 – Tables

Table S1. List of p-values resulting from Friedman tests comparing the annual averages of retention metrics (LR and SR) obtained from 7 dispersion experiments at 60, 90 and 120 m with PLD = 40 days over 1992. Significant p-values (bold, applying a 1% significant level) indicate that the mean LR/SR among those dispersal depths are significantly different, which is only the case for LR in the southern Balearic Islands and SR in the northern Balearic Islands. The remaining values suggest statistical equivalence (i.e. there are no statistical differences in the median values obtained with different depths).

Connectivity metric	**Gulf of Lion**	**Catalan coast**	**Ebro delta**	**Valencia gulf**	**North Balearic Islands**	**South Balearic Islands**
LR	0.156	0.07	0.01	0.052	0.18	**0.002**
SR	0.368	0.02	0.056	0.06	**0.002**	0.368

Table S2. List of p-values resulting from Friedman tests comparing the annual mean numbers of particles exchanged among (and, in the diagonal, retained within) 6 subpopulations computed from 7 dispersion experiments at 60, 90 and 120 m using PLD = 40 days over 1992. The significant p-values (bold, applying a 1% significant level) indicate that the numbers of particles exchanged at those dispersal depths are significantly different; this is the case for only 6 directional connections over 21 effective larval fluxes. The remaining non-significant values suggest statistical equivalence. Na indicates the absence of connection (i.e. no larval flux).

	Gulf of Lion	Catalan coast	Ebro delta	Valencia gulf	North Balearic Islands	South Balearic Islands
Gulf of Lion	**0.0009**	**0.004**	0.22	Na	Na	Na
Catalan coast	0.368	0.011	**0.002**	Na	0,074	Na
Ebro delta	Na	0.135	0.012	0.035	0.66	0.22
Valencia gulf	Na	Na	0.076	0.651	**0.004**	**0.004**
North Balearic Islands	Na	Na	Na	Na	0.276	0.368
South Balearic Islands	Na	Na	Na	0,368	0.05	**0.002**

Appendix S1 - Figures

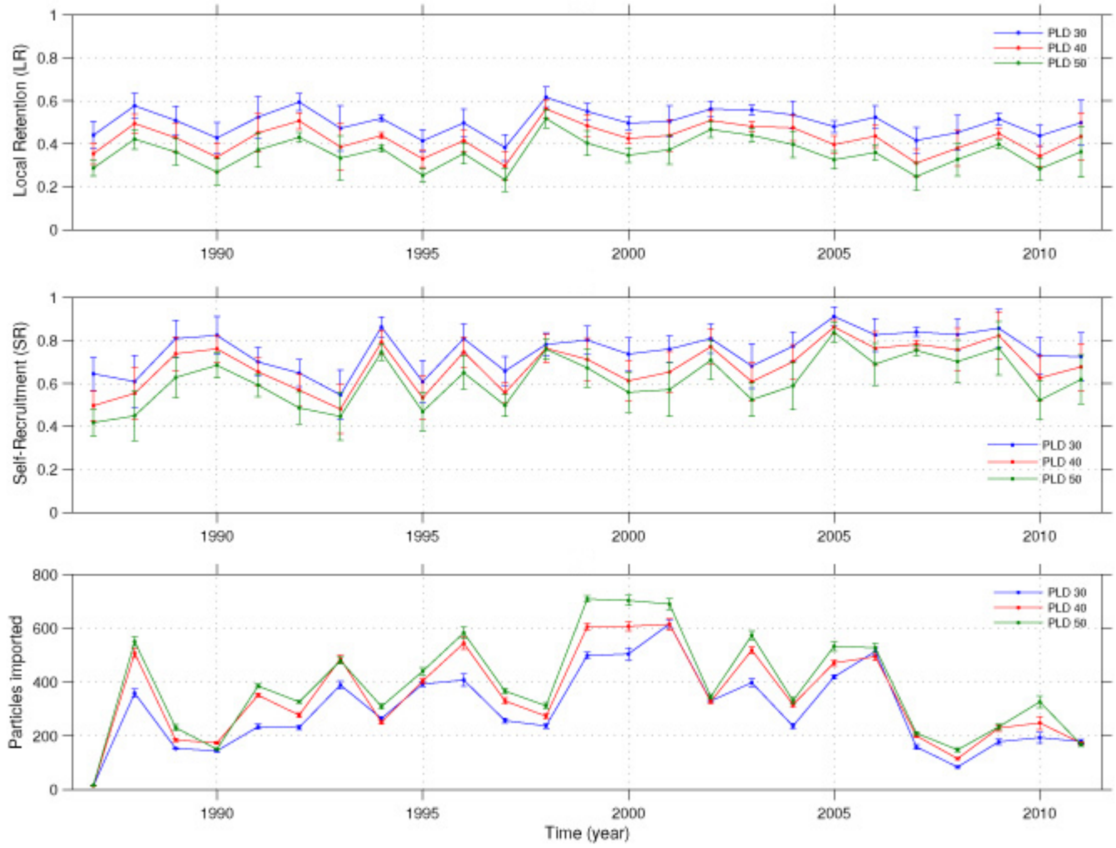

Figure S1. Time-series of regional connectivity metrics. Local Retention (LR) in the Gulf of Lion (top), Self-Recruitment (SR) over the Ebro delta (center), and particles imported (Imp) into northern Balearic Islands (bottom) for three different PLD values: 30 days (blue curves), 40 days (red curves) and 50 days (green curves). Error bars indicate the standard deviations among several spawning events.

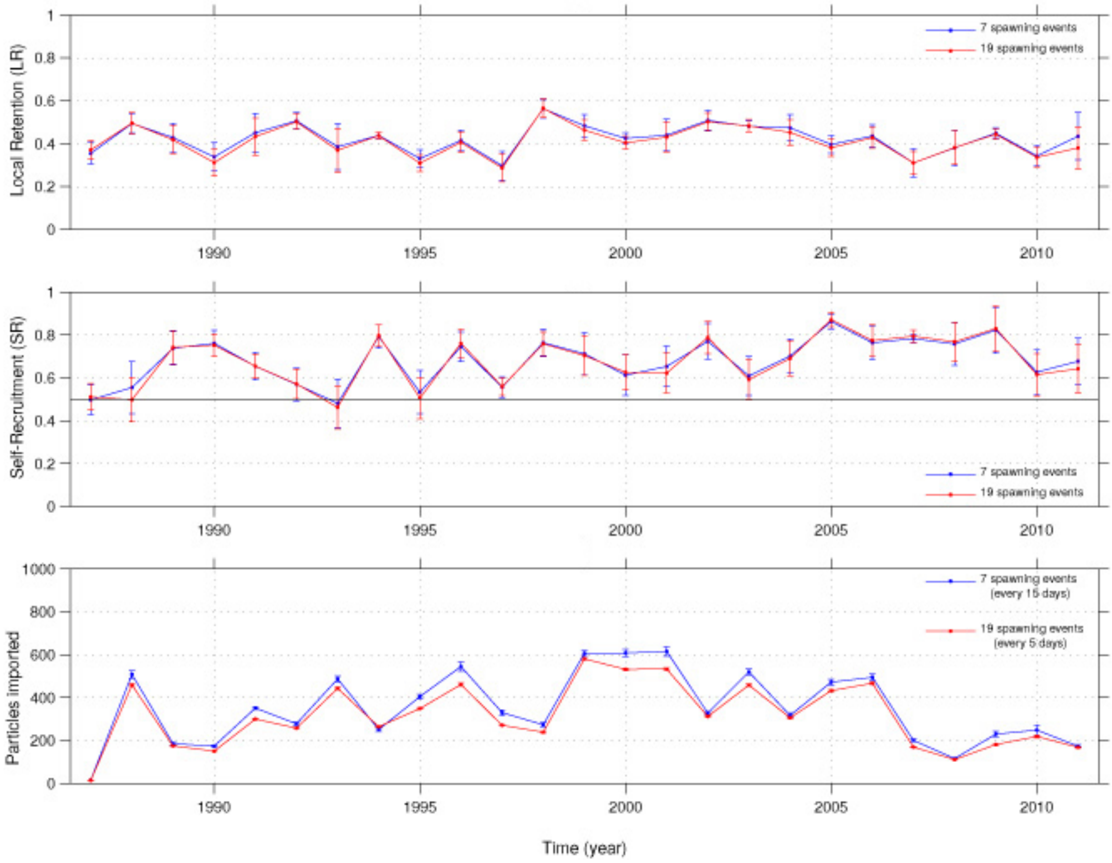

Figure S2. Time-series of regional connectivity metrics. Local Retention (LR) in the Gulf of Lion (top); Self-Recruitment (SR) over the Ebro delta (center); and particles imported (Imp) into northern Balearic Islands (bottom) for two frequencies of spawning over the same autumnal period: 7 spawning events (15 days apart, blue curves) and 19 spawning events (5 days apart, red curves). Error bars indicate the standard deviation among several spawning events.