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Sea Around Us

Ecosystems of the North Atlantic: some definitions

By Daniel Pauly, Reg Watson, Dirk Zeller, and Villy Christensen

There is a broad consensus, among scientists, that fisheries research, somehow, should be ecosystem-based, but very little agreement as to what this means (NRC 1999). Clearly, the first task when dealing with the issue of putting fisheries in an ecosystem context is, as in all science-based approaches to a problem, to define and classify the object(s) at hand. Here, these are the marine ecosystems within which fisheries are embedded.

As it turns out, establishing a consensus on such classification may be relatively easy, given the compatibility, so far never highlighted, of the two major classificatory schemes so far proposed. These are (1) the system of 'biochemical provinces' developed by Longhurst (1995) and (2) the list of Large Marine Ecosystems (LME) of K. Sherman and colleagues, recently discussed by Sherman and Duda (1999).

Longhurst's classification, based on satellite maps of plankton pigments, and verified by analysis of over 20,000 oceanographic stations, starts at the level of 'domains', or 'biomes', of which four are identified: (1) Polar; (2) Westerlies; (3) Trades; and (4) Coastal Boundary. These domains are large entities with similar climate, spanning all three oceans, and they are subdivided into 56 homogenous 'provinces', described in great details in Longhurst (1998), and called 'Longhurst Areas' in Pauly (1999).

Most of these provinces fit within one or the other ocean, the exceptions being five circumglobal (boreal and Antarctic) provinces. Overall, Longhurst's scheme makes lots of sense, and has been used to stratify the world ocean in two major studies, pertaining to the global distribution of primary production and tuna catches (Longhurst et al. 1995; Fonteneau 1998), with more forthcoming (Platt and Sathyendranath 1999). Also, as part of the collaboration between the Sea Around Us and FishBase projects (Froese and Pauly, 1998), the world's marine fishes (about 15,000 species; see www.fishbase.org) have been assigned to Longhurst's biochemical provinces, if tentatively in a few cases (R. Froese, pers. comm.).

However, these provinces are too large for most purposes of fisheries management, even on an international basis. Here, systems in the order of 200,000 km^2, i.e., the size of Sherman's LME seem more appropriate. Fortunately, it turns out that Longhurst's provinces fall into two groups, i.e., offshore and coastal (Figure 1 - page 3). The latter can easily be

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divided into 'sub-provinces' congruent with the mostly coastal LME identified by K. Sherman and collaborators.

Figure 2 (page 4) illustrates, for the North Atlantic, how Sherman's system of LME was 'mapped' onto Longhurst's classification of ocean provinces, with LME split into components (e.g. Southern and Northern) when they straddled two provinces, and new LME added where appropriate.

This synthesis provides, we believe, the elements that had been lacking within each of the systems thus rendered compatible. For Longhurst Areas, we identify sub-provinces that are pragmatically defined to serve as framework for fisheries and other applied work. As for the LME, they obtain, via their incorporation into Longhurst's scheme, the rigorous physical definitions they had so far been lacking, including borders that allow GIS-based computation of system properties.

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Another consideration is that our synthesis can be used as ecological complement to the coarse stratification scheme used by the Food and Agriculture of the United Nations (FAO) to present global marine fisheries data, and which relies on 18 FAO statistical areas (7 for the Atlantic, 3 for the Indian and 8 for the Pacific Ocean). To facilitate comparisons between catch data stratified by these two schemes, we have split the five circumpolar provinces into ocean-specific segments, treated here as LME (lower level of Figure 2). This procedure enables 'closure' of each ocean and thus will allow direct comparisons, at least at ocean-level scale, between catch data stratified within our new system, and the FAO catch data.

Our next task, in this context, is to assign the catches in the global FAO data set to provinces and sub-provinces (=LME), pending their gradual replacement, starting with the North Atlantic, by locally-derived data sets. Further, we are in the process of assigning Ecopath models of the North Atlantic to the ecological stratification scheme described here, with the purpose of deriving basin-level estimates of production patterns and ecosystem state variables.

Acknowledgments:

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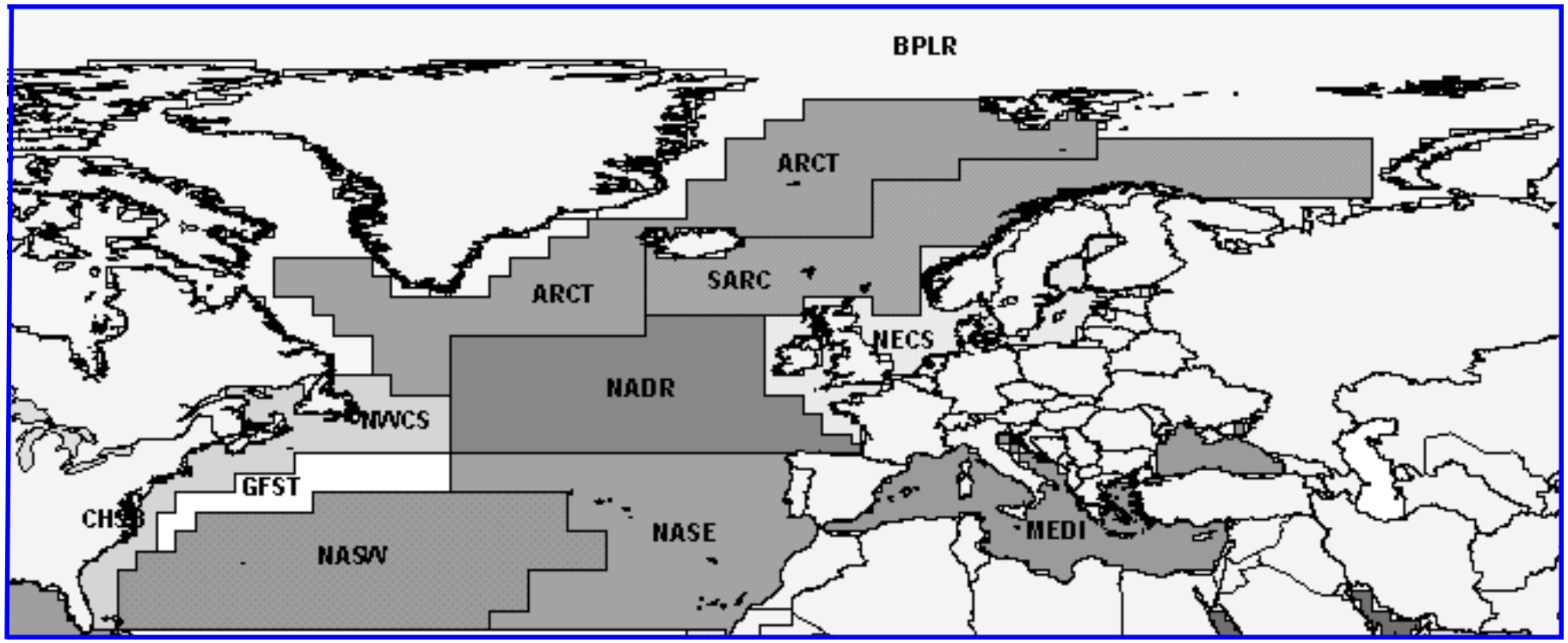

Figure 1: *Biochemical provinces of the North Atlantic described by Longhurst (1995). Figure 2 shows the LMEs so far identified for each province.*

ARCT (Atlantic Arctic Province)
CHSB (Chesapeake Bay Province)
NADR (North Atlantic Drift Province)
NASW (North Atlantic Subtropical Gyral Province)
NWCS (Northwest Atlantic Shelves Province)
BPLR (Boreal Polar Province)
GFST (Gulf Stream Province)
NASE (North Atlantic Subtropical Gyral Province)
NECS (Northeast Atlantic Shelves Province)
SARC (Atlantic Subarctic Province)

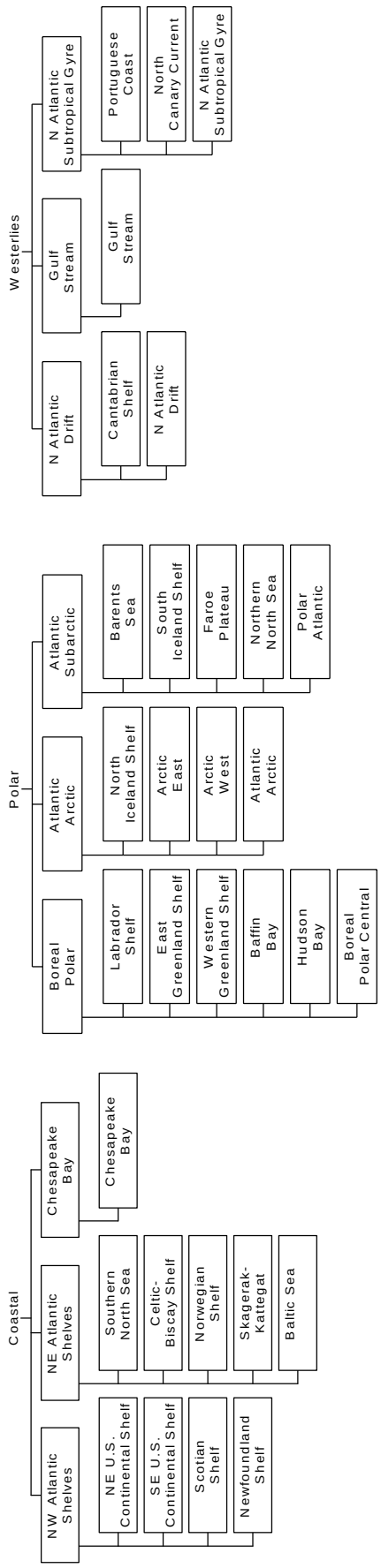

Figure 2: Result of 'mapping' K. Sherman's and other LMEs into the biochemical provinces described by Longhurst (1995) for the North Atlantic (see also figure 1). Note hierarchy from the 'domain' level (Coastal, Polar, Westerlies) to the province (N.W. Atlantic Shelves, etc.), and the LME (N.E. US Continental Shelf, S.E. US Continental Shelf, etc.). A similar breakdown is now available for the rest of the world's oceans. Also note that further breakdown (i.e., addition of LME) will probably be required for detailed description of various provinces.