Stock Definition: Terminologies revisited

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A long-standing objective within the Stock Definition Working Group has been to develop a suite of definitions for stock related terms below the species level (for original Terms of Reference see Appendix). Here we summarize past discussions and usage of these definitions outside the IWC in order to provide a list of defined terms in use in the management and conservation contexts, and describe how they relate to other terms.

Key IWC management terms

Biological population –there are multiple ecological and evolutionary definitions of this concept, as summarized in Waples and Gaggiotti (Table 1, 2006) and Wells and Richmond (Box 2, 1995). In general, the term population can apply to groups of individuals which are spatially, genetically *or* demographically disjunct from other groups (Wells & Richmond 1995).

Ecological definition: A group of individuals of the same species who interact within a particular geographical area or biome at a particular time. This paradigm can encompass sufficient size that all requirements for reproduction, survival and migration can be met, or can just relate to the particular habitat patch in which the individuals are found at that time. The group of individuals is sufficiently isolated that immigration does not substantially affect the population dynamics or extinction risk over a 100-year time frame.

Evolutionary definition: A group of sexually reproducing individuals of a species living in close enough proximity that any member of the group can interbreed any other member, exhibiting reproductive continuity from generation to generation and across the geographical space of the population.

Biological Stock –a species, group, or population that maintains and sustains itself over time in a definable area. This is sometimes qualified by a type, e.g., biological or management. In SC54/Annex I, 'Biological stock' was defined as *all the individuals in an area that are part of the same reproductive process, forming a self-contained unit, with emigration/ immigration rates far lower than the intrinsic rate of population growth*. This is similar to the ecological definition of a biological population, where immigration rates are insufficient to influence population demographics. A biological stock may not always match a 'management unit' (sometimes referred to as a 'management stock'); this latter can be a subunit of a biological stock, *e.g.,* Donovan (1991). We suggest that 'management stock' is instead referred to as a management unit, since this is the level at which active assessment is carried out (see 'management unit'). The SD working group elected to discontinue use of the solo term 'stock' in 2002 (in favour of 'population') but it is still being used frequently.

Sub-stock –FromSC/54/Annex I: "this [deliberately vague] term describes a group of animals with some degree of biological cohesion (i.e. they may be found together on a shared feeding ground but not necessarily also the same breeding ground). Closed sub-stock: sub-stock with negligible interchange with animals outside that sub-stock (i.e. at rates far lower than the intrinsic rate of population growth), e.g. West Greenland feeding sub-stock of humpback whales."

The term 'sub-stock' can therefore be used to define *a component which occupies a particular ecological niche within a geographically defined, inter-breeding stock*, e.g.

employs a particular feeding strategy or has fidelity to a particular migratory route. This feature should be persistent over time and have a genetic component, e.g. the strategy or route is inherited from a parent. While gene flow among sub-stocks can be high, i.e. they may share a breeding ground with individuals from other sub-stocks; removal of individuals from one sub-population may result in depletion of individuals within their particular niche (i.e. feeding group) over management relevant time scales. Sub-stock 'boundaries' can be difficult to define because one feeding sub-stock may mix with other feeding sub-stocks which are each connected to geographically separate breeding grounds. Identification of such sub-stocks usually requires use of individual or population level identification or assignment approaches.

Management unit **-**demographically independent populations whose population dynamics (e.g. population growth rate) depend *largely* on local birth and death rates rather than on immigration(Palsbøll *et al*. 2007). In SC53/Annex I: "management units should be defined such that local extirpations are to be avoided, and that local depletions will recover to healthy levels on a *management timescale*; the scale of 'local' depends on management objectives." A key factor for defining management units (MU) is the dispersal rate between population units. Extremes are fairly safe- low dispersal means the MU can be easily identified, high dispersal means the MUs should be aggregated; intermediate means that there could be unintentional local extirpation if genuine MUs are spatially aggregated. MUs are often identified by differences in frequencies of mtDNA haplotypes or nuclear alleles, regardless of the underlying phylogeny, *i.e*., evidence of limited gene flow (Moritz 1994), although they can also be drawn along non genetic lines, e.g. through geography or demography. A list of informative non-genetic metrics is provided in Table 1 of SC54/Annex I.

In SC53/Annex I: "Management unit is a human construct defined in the context of management, that may or may not be equivalent to a single biological stock. It refers to animals that happen to be present in a defined region and season where management is taking place or contemplated. The term has a close connection to Area definitions within the RMP, and therefore must be used carefully in the IWC to avoid RMP/AWMP implications, unless specifically intended".

Relation to RMP- (IWC 1999, p251-258): "*Medium areas* correspond to known or suspected ranges of distinct biological stocks. *Small Areas* are disjoint areas small enough to contain whales from only one biological stock, or be such that if whales from different biological stocks are present in the *Small Area*, catching operations would not be able to harvest them in proportions substantially different to their proportions in the *Small Area"*. *Medium Area* is therefore closest in definition to the biological stock while Small Area is closest to the sub-stock.

"Unit-to-conserve" **-**(also known as 'conservation units').The 'unit to conserve' depends partly on biology and partly on the level of political and economic interest in the species. The unit to conserve is often an amalgam of the unit that best matches societal ideals (a policy driven decision) and units that exist in nature, with a lot of iteration between both elements (Taylor 2005). Taking the precautionary approach the unit to conserve might be the smallest division of the population that can be determined as a semi-autonomous unit (here the 'sub-stock'). At the other end of the spectrum the unit to conserve might be the species itself, regardless of range or population structure. In the IWC context it may be considered equivalent to a management unit.

Other non IWC management terms

"Ecotype" **-**a population distinguished by morphological and physiological characters, most frequently of a quantitative nature; inter-fertile with other ecotypes and ecospecies, but prevented from exchanging genes by ecological barriers (Gregor *et al.* 1936).

"Metapopulation" –a set of spatially disjunct populations, among which there is some immigration (from Wells & Richmond 1995). It can be considered as a population composed of sub-populations, *i.e.*, management units or sub-stocks

"Evolutionarily Significant Units"(ESU)_–sometimes defined in a similar way to sub-species, with requirements of monophyletic mtDNA and significant nuclear allele frequency differences compared to other units (Moritz 1994). This is the most stringent definition although there has also been debate over how much mtDNA differentiation is required to designate an ESU; this may be determined by comparison with diversity (*i.e.*, intra-population divergence) levels of related species. Other researchers define the ESU as a population that is 'substantially reproductively isolated from con-specific population units, representing an important component in the evolutionary legacy of the species'(Waples 1995). This definition is synonymous with the US 'Distinct Population Segments' designation but is difficult to define quantitatively (Cronin 2006).

"Deme" –a group of individuals which are more genetically similar to each other than to other individuals, usually with an additional element of spatial isolation (Wells & Richmond 1995). This can be synonymous with a biological sub-stock (management unit) or with an ESU.

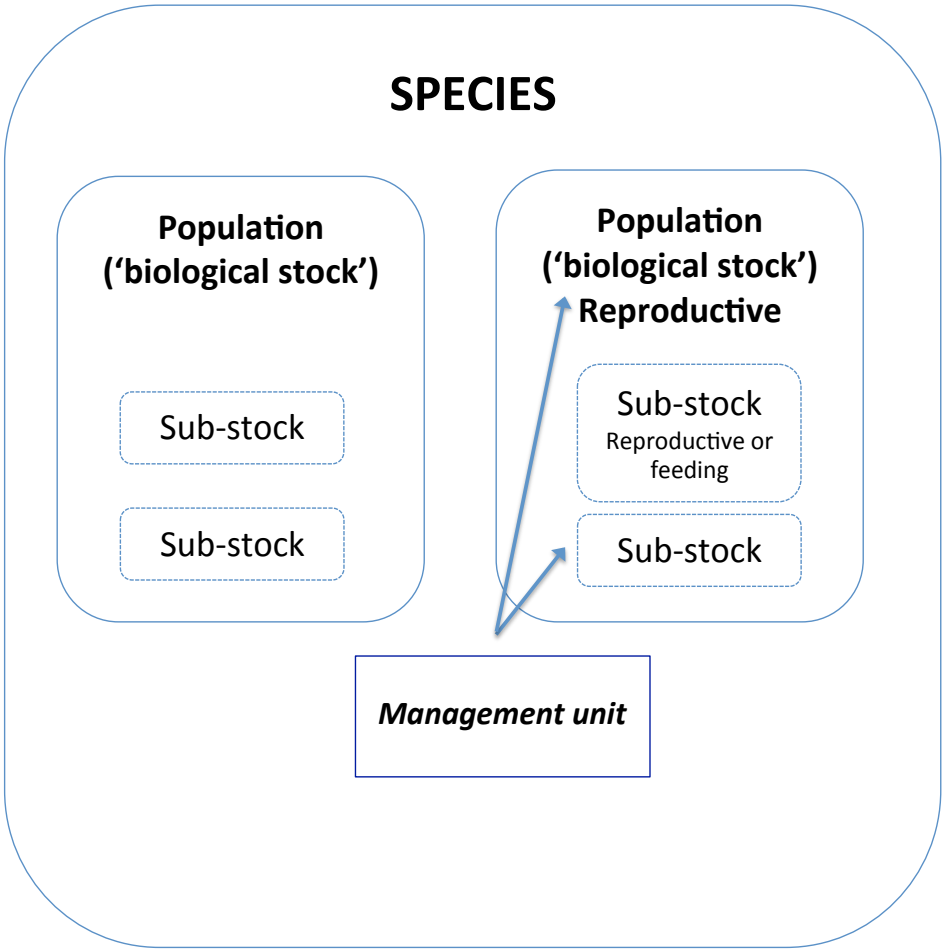

Figure 1. The relationships between stock definitions. Dotted lines indicate that group boundaries may not be defined by geography or habitat.

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APPENDIX

SD50: Original Terms of reference for SDWG

1. Review the published literature regarding the current usage of the stock concept in managing renewable resources, with special emphasis on long-lived highly mobile species
2. Prepare a report summarizing the results of the review, particularly in the context of the RMP and AWMP
3. Review case studies of management advice for large whales with special emphasis on the extent to which the definition of a stock used in the assessment contributed to or detracted from the success of the assessment, with particular reference to the level and nature of the available data
4. Prepare a report summarizing the results of the review
5. Assess the results of studies using suitable spatially explicit population simulation models for the purpose of evaluating the relationships among population size, various rates of movement between putative stocks, methods of analysis, effect size and experimental design, taking into account the approaches presently used in developing ISTs in the RMP and possible approaches used in developing future AWMPs
6. Endeavour to refine existing stock definitions on the basis of the above mentioned reports and activities
7. Assess the desirability and means of considering multiple lines of evidence, including evidence from studies, on movement patterns, morphology and ecology, as well as genetics, in developing definitions of stocks