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Limits of Acceptable Change

The definition and operation of concepts and approaches for "limits of acceptable change" which may be applicable to the Ramsar context of defining and detecting change in the ecological character of wetlands

Information paper prepared by the Scientific and Technical Review Panel

Summary

This paper gives a broad overview of existing approaches and other considerations concerning the definition and operation of concepts and approaches for "limits of acceptable change" (LAC) which may be applicable to the Ramsar context of defining and detecting change in the ecological character of wetlands, as required by Article 3.2.

The paper identifies different purposes for LAC in the context of existing Ramsar information management and decision-making frameworks. It highlights conceptual distinctions between interpretations of "trivial" change, benchmarks for establishing the range of normal variability, recreational management compromise protocols, precautionary envelopes for ecosystem status reporting, early warning indicators, adaptive management triggers, expressions of risk appetite and degrees of approximation/tolerance bandwidths for the achievement of conservation objectives.

Examples of existing approaches are given from Austsralia, the European Union, South Africa, the United Kingdom, and the United States, as well as from the Convention's own guidance. Some of these approaches operate with substantial volumes of data and well-resourced agencies, but any global Ramsar standards or guidance which may be developed on this issue will need to cater for more capacity-constrained parts of the world, perhaps through a "framework" or "tiered" approach. Elements of the scope of desirable future work by the Ramsar Scientific & Technical Review Panel towards this are identified.

The term "Limits of Acceptable Change" has been used in significantly different ways in different contexts, giving rise to some confusion and mistaken conceptual extrapolations. It is suggested that different terminology should be used for defining "how much change constitutes relevant change" for the purposes of Article 3.2. For Article 3.2 purposes it is therefore recommended that the term "Limits for Defining Change in Ecological Character" (LDCEC) should be used instead.

Contents

1. The purpose of this paper: addressing a specific gap in Ramsar guidance

1. This paper has a narrow purpose – it is intended to support the implementation of specific requirements under Article 3.2 of the Ramsar Convention concerning sites in the Ramsar List of Wetlands of International Importance (Ramsar Sites). There is a substantial body of literature and practice on concepts and approaches that use "limits of acceptable change" or similar terminology for other purposes in the environment sphere more generally, and while they will be referred to here, this paper does not purport to provide advice on those wider aspects.

2. Article 3.2 requires that "Each Contracting Party shall arrange to be informed at the earliest possible time if the ecological character of any wetland in its territory and included in the List has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference. Information on such changes shall be passed without delay to the organization or government responsible for the continuing bureau duties specified in Article 8 [i.e., the Ramsar Secretariat]".

3. The Parties have adopted definitions of ecological character and change in ecological character (Resolution IX.1 Annex A, 2005), as well as guidance on describing ecological character (Resolution X.15, 2008) and on detecting, reporting and responding to change (Resolution X.16, 2008). Further elaboration of these issues is provided in Information Document 27 for the 10th meeting of the Conference of the Contracting Parties (COP10, 2008).

4. One question that remains is that Article 3.2 is unqualified as to the magnitude or significance of the changes in ecological character of wetlands to which it refers. It implies that any change, no matter how trivial, should be reported. Clearly to do so would be neither practical nor helpful, but the Convention has never spelled out a way of deciding how big a change is a "real change" for this purpose, nor how to take account of naturally fluctuating baseline states. Further guidance on this has therefore been seen as useful for assisting Parties in meeting their commitments, and has been requested by the Conference of the Parties since as long ago as 2002 (Resolution VIII.8).

5. At COP10, the Parties in Resolution X.10 (2008) defined a task for the Scientific and Technical Review Panel (STRP) on the development of guidance on "limits of acceptable change" in this context. The STRP determined that it would not be in a position by the time of COP11 to provide a comprehensive treatment which could be adopted as a decision or guidance by the COP, but it agreed that a review paper to gather perspectives on the subject from existing practice and thinking around the world would be an essential first step. The present paper provides this review.

2. The two main parts to the question in the Ramsar context

6. The issue may be considered to have two main parts. The first concerns the idea that despite the unqualified terms of Article 3.2, some instances of change ought on any reasonable view to be regarded as too trivial to require reporting, meaning in effect that they are not regarded as change at all within the terms of the Article. The question then is how to define generally, or decide in an individual case, what is the cut-off threshold between a) trivial changes which can be ignored and b) other changes which may be indicating something real that requires a response.

7. The second part concerns the definition of the pre-existing or baseline state against which the arrival of a change is to be discerned. The categories of baseline information, and some elements of the precision with which it should be described, are covered in the Convention's guidance on describing wetland ecological character (Resolution X.15, 2008) and on the Ramsar Information Sheet (see Ramsar Secretariat, 2010, and the updated version of the RIS tabled at COP 11 in Annex 1 to Draft Resolution 8). Guidance to date however has not discussed how to distinguish between a) a Ramsar Site's natural range of variation and b) some perturbation which becomes superimposed on it and signals an issue of concern.

3. Trivial or *de minimis* change

8. Several fields of law, finance and quality assurance operate a concept of triviality referred to as "*de minimis*". In the legal sphere this derives from the Latin phrase "*de minimis non curat lex*", or "the law does not concern itself with trifling matters". In a planning law context, for example, it can refer to aspects of development or land-use change which are sufficiently trivial as not to qualify as development at all for the purposes of planning regulations. The way this may be manifest tends not to be objectively prescribed in statutes, but to be ultimately a matter of judgement by the courts based on the facts of an individual case.

9. Such judgements need to address the effect of the change as well as its inherent nature/magnitude. In the Ramsar Site context, triviality or significance is not something that will be judged, for example, simply in terms of the extent of the wetland area affected by change, since the question relates to the ecological character and the functionality of the wetland.

10. The same legal and financial fields also commonly operate a complementary concept of "materiality". Again the determination of what is or is not a "material change" is a matter of judgement based on the facts of the individual case, assessed with regard to the relative (rather than absolute) significance of the issue in its context, and with regard to its potential effects (for example, whether a decision or other outcome could reasonably be assumed to be influenced by the change).

11. Some approaches to this question suggest further distinctions (which, applied to ecological situations at least, are not necessarily mutually exclusive). "Materiality by value" would concern a magnitude of change that of itself is inherently too large, relative to the field of interest in question, to be reasonably ignored. "Materiality by nature" would concern a change which may not be large in value but which is of key importance or sensitivity, perhaps concerning a critical variable on which many other variables normally depend, or which has special sensitivity in terms of available responses. "Materiality by context" would concern a change which at one site may be neutralised by other factors and have no effect, but at another site may be exacerbated by other factors and have a material effect, perhaps being the final incremental ingredient which produces a "tipping point" or "threshold change" from one state to a different state.

12. A practical conclusion to this might be to acknowledge that Article 3.2 could be read as though it contained the qualification which it has so far lacked, namely a *de minimis* exclusion. Guidance could be formulated in support of this (and to deter its misuse as a broader derogation), drawing upon the points above.

4. Natural/typical range of variation and the definition of baselines

13. Ramsar guidance makes reference in several places to the "naturally functioning [wetland] ecosystem" as part of the reference conditions against which objectives are set and changes are monitored. What constitutes "natural functioning" is a judgement that will normally need to be site-specific, and hence it is not a subject on which global Ramsar guidance has been developed.

14. The same applies to the natural (or often more correctly perhaps, the "typical") tendency which may be exhibited by a given site to vary over time. This is usually interpreted to relate to fluctuations around a mean position rather than directional tendencies, but natural succession may sometimes be relevant, and climate-related change may add another layer of complexity (see below).

15. The guidance adopted by the Parties has noted the importance of considering the natural variability when establishing baselines. Resolution VI.1 in 1996 stated that "Monitoring should establish the range of natural variation in ecological parameters at each site, within a given time frame. Change in ecological character occurs when these parameters fall outside their normal range".

16. This was then reinforced in guidance on completing the Information Sheet on Ramsar Wetlands (RIS). This guidance has evolved through several iterations over the years and was most recently published in consolidated form in Wise Use Handbook 17 (4th Edition, 2010). It is now tabled for adoption in a further updated form as Annex 2 to COP11 Draft Resolution 8 (DR8), where the process for documenting information for the purposes of the RIS is integrated with that for compiling descriptions of the ecological character of wetland sites (the present discussion is equally relevant to both of these processes).

17. The guidance notes that a completed RIS should include "information on the natural variability and amplitude of seasonal and/or long-term 'natural' changes (e.g., vegetation succession, episodic/catastrophic ecological events such as hurricanes) that have affected or could affect the ecological character of the site". The accompanying guidance on providing maps and other spatial data further advises that "Where there is substantial seasonal variation in the extent of the wetland, separate maps showing the wetland extent in the wet and in the dry seasons are helpful".

18. Information on variability should also be captured in relation to explanation of the site's qualification under the selection criteria for listing it as "internationally important". Guidance is given on this in relation to cases where the application of waterbird criteria 5 and 6 is relevant (*Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance* in Ramsar Handbook 17, and updated version annexed to COP11 DR8). The guidance states: "In establishing long-term 'use' of a site by birds, natural variability in population levels should be considered especially in relation to the ecological needs of the populations present. Thus in some situations (e.g., sites of importance as drought or cold weather refuges or temporary wetlands in semi-arid or arid areas – which may be quite variable in extent between years), the simple arithmetical average number of birds using a site over several years may not adequately reflect the true ecological importance of the site. In these instances, a site may be of crucial importance at certain times ('ecological bottlenecks'), but hold lesser numbers at other times. In such situations, there is a need for interpretation of data from an appropriate time period in order to ensure that the importance of sites is accurately assessed."

19. The *New Guidelines for management planning for Ramsar Sites and other wetlands*, annexed to Resolution VIII.14 in 2002, also advise that in the site management planning context, "Limits for ecological character features should be developed in recognition of the natural dynamics and cyclic change in populations and communities". (The management planning guidelines, and the issue of developing limits, are both discussed in later sections of this paper).

20. COP10 Information Document 27, referred to above, noted that the Commonwealth (federal) Government of Australia had been developing guidance on issues concerning the ecological character of its Ramsar Sites (subsequently published in DEWHA, 2008), according to which wetland managers would be expected to "describe the natural variability … for each of the critical components, processes and benefits/services of their wetland" and to "quantify the typical range of variability for the critical components, processes and services". It has also been noted that this is particularly important for Australian wetlands given that they often have a large range of natural variability (NSW DECCW, 2010).

21. In implementing the Australian system, ranges of known values for a suite of indicators have been documented for a number of sites. This is the logical method for arriving at a variability description, but at best it can be regarded as an approximate impression of relevant variability. As the *New Guidelines for management planning* point out, "In reality, there are very few features for which the natural fluctuations are fully understood". Even where long time-series data are available, different but equally "natural" fluctuations may have occurred in earlier historical periods, including even "step" changes between different stable states (see, e.g., Beisner *et al.*, 2003, Rockström *et al.*, 2009 and Steffen *et al.*, 2011).

22. This brings home the fact that the description of baselines, as discussed in the context of this paper, is a somewhat artificial construct for the particular expedient of operating the Convention's "change-reporting" requirements. It is subject to distortion by artefacts such as the choice of designation/ecological character description date, non-standardised levels of research effort, and the evolving efficacy of survey techniques. It should not be over-interpreted beyond its design tolerances, and the assumptions and limitations that apply in any given case should always be explicitly stated.

23. It is important also to note that the use of "natural variation" information in this context is not simply a question of trying to distinguish the "noise" above which we wish to detect a "non-fluctuational" "signal", since the change requiring a response in a given case may be to the characteristics (e.g., the timing) of the fluctuations themselves. The Australian guidance cited above states that "For some wetlands there may be a trend of change in the natural variation of the system over time, so it is important to review the limits of ecological change over time to ensure they still reflect the natural variability of the system. However, care should be taken to ensure that such changes are really the natural variability or trend of the system and not a human induced change in the system."

5. Issues relating to climate change

24. Climate change is a special case in the consideration of background baselines. There may be a) some climatic phenomena which are examples of cyclical fluctuations and b) others which (or the results of which) are examples of anthropogenic directional change that should be of concern in relation to the Ramsar objective of maintaining the ecological character of listed sites.

25. A first problem with this is that the dividing-line between these two things is often contested, on philosophical as well as scientific grounds. Ramsar Article 3.2 requires reporting only of change in ecological character that is anthropogenic ("the result of technological developments, pollution or other human interference"). The degree of consensus about whether climate change is or is not such a change is however not the main issue here: rather it is the difficulty of attributing cause and effect in these terms in relation to observed differences at any individual wetland site.

26. A second problem is that the Article 3.2 regime is designed with the aim of triggering feasible responses in policy or (more usually) site management, in respect of remediable change. If climate-related change (whatever its cause) arises remotely (or globally) and inevitably from historical causes, then this purpose may already be thwarted. As has been discussed elsewhere (see, for example, Resolution IX.6 on *Guidance for addressing Ramsar*

Sites or parts of sites which no longer meet the Criteria for designation, and the accompanying COP9 Information Document 15 on *Issues and scenarios concerning Ramsar Sites or parts of sites which cease to meet or never met the Ramsar Criteria*), the Convention has historically not been well equipped with mechanisms for addressing implementation failures that arise from causes outside the control of the responsible government authorities.

27. Taking these issues into account, the STRP concluded at its mid-term workshop meetings in February 2010 that change in wetland ecological character as a result of climate change should be regarded as lying beyond the scope of Article 3.2 (regardless of whether or not it is anthropogenic), and that the use of Article 3.2 in this context should be discouraged. The context for consideration of climate change is instead Resolution X.24 (2008) on *Climate change and wetlands* and COP11 DR14 on *Climate change and wetlands: implications for the Ramsar Convention on Wetlands*.

6. Setting limits: the system of LAC for recreation in US national parks and its application elsewhere

28. There is a case for saying that this paper starts from a wrong premise, and that Limits of Acceptable Change (LAC) is not the appropriate term upon which to construct the necessary concepts or tools for knowing how much change constitutes relevant change for the purposes of Article 3.2. This is because a process with the same name has been in common currency in the protected areas sphere for many years, specifically in the United States, but with a different meaning. The two should not be confused – but at the same time there are potential points of connection. It therefore makes sense to examine this US process first, to clarify these distinctions and to determine what, if anything, may be transferable to the Ramsar purpose.

29. Google returns some 77,400 results for the specific phrase "limits of acceptable change". It appears that most of these relate to the framework developed by the US Forest Service in the 1980s for recreation management in wilderness areas and national parks in the US. The historical development of this framework is reviewed by Cole and Stankey (1998), who attribute the origin of the LAC concept in this context to an unpublished University of Minnesota Masters thesis in 1963 by Sidney S Frissel Jr, which related in turn to concepts of visitor "carrying capacity" or "saturation point" which had existed since the 1930s.

30. The application of the carrying capacity concept in this context was felt to be flawed and not successful in achieving the desired objective. While useful in a general way to encourage discussion about visitor impacts, it derived from biological models of the capability of resources to sustain a given number of animals over a period of time in a particular place, and did not translate readily into the management of human recreational experiences (McCool, 1996).

31. The carrying capacity concept was also felt to be problematic in the sense that it implies that there is an absolute threshold of (for example) visitor numbers below which there is no impact. Frissel explained instead that if recreation use is to be allowed at all, some deterioration is inevitable and must be accepted, but a limit should be placed on the amount of change to be tolerated, and when a site reaches this predetermined limit, steps should be taken to prevent further adverse change. Formalisation of this idea was seen as

an improved way of developing "visitor carrying capacity plans" for US wilderness areas and national parks, pursuant to requirements in the 1976 National Forest Management Act and the 1978 General Authorities Act respectively.

32. Regulations under the 1976 Act refer to "estimates of the maximum levels of use that allow natural processes to operate freely and that do not impair the values for which wildernesses were created". It was soon realised, however, that different recreationists seek different experiences in wilderness, and carrying capacity could thus only be defined within the context of specific (recreational) management objectives. Objectives defined in most management plans of the time were highly generalised, both in relation to recreational outcomes and in relation to desired environmental conditions (for example, "maintain natural conditions"), and were of no help in distinguishing problem situations, identifying promising management options, or evaluating success.

33. In addition, capacity in relation to one variable is only practically meaningful when related to other linked variables. For example, the size of a visitor group which can acceptably be accommodated within a specific natural area will be dependent on other factors such as the competence of tour guides, the quality of interpretative material, the behaviour and age of the visitors, and so on. Establishing cause-effect relationships when varying the size of the group is thus problematic (C García Saez, *pers comm*). Rather than seeking to define the "correct" maximum capacity, therefore, the approach shifted to constructing monitoring and planning protocols based on levels of impact, with impact being considered both in terms of the receiving environment and in terms of the visitor experience.

34. In response, the Forest Service published "The Limits of Acceptable Change (LAC) System for Wilderness Planning" (Stankey *et al.*, 1985), incorporating a framework concept known as the Recreation Opportunity Spectrum (ROS). Its first application was documented in a Forest Plan amendment for the Bob Marshall Wilderness Complex in 1987. Related processes were developed, including the Carrying Capacity Assessment (1986), Visitor Impact Management process (1990), and Visitor Experience and Resource Protection process (1993).

35. The LAC system has been the most widely applied of these. Its approach begins by focusing management on achieving objectives defined in terms of staying within maximum acceptable deviations from a) the natural range of variation in ecological conditions and b) the ideal of a "pristine wilderness [visitor] experience". The system however is designed to achieve an acceptable compromise between these goals and the goal of achieving recreational use. In this context, it is fundamental that LAC standards are "statements of minimally acceptable conditions" [which] define "the compromise that we desire – not the conditions that we desire", and the process is said to be "of little value [in cases where] managers are unwilling to compromise one of the goals" (quotations are from Cole and Stankey, 1998).

36. In this respect, it operates such that when limits on one parameter (e.g., resource condition) are reached, another parameter (e.g., intensity of recreation use) is restricted in order to avoid further deterioration, until the limits of acceptable restriction of that parameter are reached, whereupon perhaps another parameter (e.g., extent of access) is restricted, and so on.

37. Typical descriptions of the US LAC process follow "nine steps" as described by Stankey *et al.* (1985), although there are other re-workings of this, such as a version condensed into six steps by Glasson *et al.* (1995). The original nine steps in summary are:

    i) Identify area concerns and issues;
    ii) Define and describe "opportunity classes" (based on the ROS concept);
    iii) Select indicators of resource and social conditions;
    iv) Document existing resource and social conditions;
    v) Specify standards for resource and social indicators for each "opportunity class";
    vi) Identify alternative opportunity class allocations;
    vii) Identify management actions for each alternative;
    viii) Evaluate and select preferred alternatives; and
    ix) Implement actions and monitor conditions.

38. "Opportunity classes" refer to a categorization of areas as "pristine", "primitive", "semi-primitive", "rural", "urban", etc. It is not necessary for present purposes to go into this or the detail of the different steps. Step 5 however has some relevance to the question of defining limits, as it involves identifying the measurable range of conditions considered "appropriate and acceptable" (and hence allowable) for each of the indicators defined in step 3 for each opportunity class, drawing on data from step 4. These standards serve as the "limits of acceptable change" (not objectives to be attained). They should be realistic, while not simply mimicking existing conditions where those are deemed unacceptable. In this system they are also designed to link to feasible management responses in the event of a limit being breached.

39. Standards will cover resource conditions (e.g., intensity of use of trails) and social conditions (e.g., frequency of encounters with noise, litter, other people, etc). The point of the standards is that they should not be violated, but tolerances can be built in, for example by expressing a standard in terms of probabilities: a solitude standard in a given opportunity class, for example, might be to the effect that "contact between different groups on a trail will not exceed four contacts per day on at least 90 percent of days", thus allowing a few instances of exceeding the standard per season without needing to invoke the prescribed management response (e.g., restriction of use). The results of step 5 can then be summarised in a table of specific (quantified where possible) measures of acceptable conditions for each indicator in each opportunity class.

40. The "US" visitor management LAC system has also been applied in other parts of the world, including for wetland areas. Mbaiwa *et al.* (2008) applied it in a pilot project at two tourist sites in the Okavango Delta, Botswana, in a context of growing tourism in the Delta. Ideas concerning limits to change were examined by surveying attitudes of tourism stakeholders and tourists toward present and future conditions. Limits were discussed in terms of issues such as numbers of safari vehicles in use, quantities of litter, density of roads, and amount of noise. Each of these can potentially involve a combination of ecological and social (amenity) dimensions, but in this case the analysis clearly leaned towards the latter.

41. García Saez has employed the US LAC system in compiling visitor management manuals for tourism and protected areas in Cuba, Honduras, Mexico and Panama (see for example García Saez, 2006). An example of limits defined in these protected areas is the number of

scars caused by boat groundings in representative seagrass bed sample plots, and the number of scarring incidents witnessed by enforcement personnel, linked to a protocol for management responses.

42. A summary account of stakeholder workshops used to establish LAC at the Maya sites Yaxchilán and Piedras Negras (Guatemala and Mexico) is given in an article published by the World Monuments Fund (WMF, 2002). Focused on archaeological assets, but in their ecological context (the large and complex system of the southern reaches of the Usumacinta River), the consultation process explored issues such as how many visitors could be accommodated at the sites without eroding their value, while also drawing direct parallels with renewable rates of extractive natural resource utilization (such as forest products). It considered the ecosystem as well as the needs of the indigenous human communities inhabiting the area.

43. IUCN's toolkit for managing Marine Protected Areas in the Western Indian Ocean (IUCN, 2004) refers to some past attempts to determine carrying capacities for diving activity in coral reefs, but points out that these assume that the amount of diving is a reliable indicator of damage to the reef, whereas in fact the behaviour of divers, the activities they carry out, and the physical and ecological characteristics of the reef cannot be neglected, while in some cases the impacts of diving may anyway be eclipsed by the impacts of unsustainable fishing. In line with the arguments above, therefore, the toolkit turns to the LAC approach for "defining the limit of ecological or sociological change (which may involve some degradation) that will be allowed at a site", as a basis for identifying management actions needed to prevent change beyond the limit. Its application in the Saba Marine Park (Netherlands Antilles) is cited, and reference is also made to the similar method applied in South African National Parks under the name "Thresholds of Potential Concern" (see section 12 below).

44. In New Zealand, a thesis study applied the US LAC system to the Mingha-Deception track in Arthur's Pass National Park (McKay, 2006). The emphasis here was on involving stakeholders (by means of workshops) in determining values, issues and concerns and also in specifying the levels of acceptable impacts, having regard to the measured levels of actual impact at each study site. Unsurprisingly, therefore, this study concentrated on the "sociological" dimension, addressing limits for aspects such as signage adequacy and provision of toilets and shelters. Stakeholder ratings were averaged, which in the present context raises a question about sensitivity of limit-setting and about precaution, which is discussed further below.

45. A case study in the UK applied the US LAC approach to the upland protected area of Aonach Mor, in Scotland (Young, 2003). In this case, limits were established through a process involving a working group of stakeholder organisations and independent ecological consultants. The area of Aonach Mor includes a ski resort constructed in 1989; and the motivation to establish limits of acceptable change arose from concerns on the part of the Countryside Commission for Scotland about the environmental and visual impacts of this resort, based on experience with others that had been constructed in the 1960s. Issues included damage to sensitive arctic-alpine vegetation along tow lines and ski runs, litter, path development, queuing times at lifts, and bare ground patch size. Examples of limits include: 90% of original vegetation cover; mean trampled path width (path-specific limits ranging from 0.5-4.5m); 15 items of litter per linear kilometer; 4 m^2 or 4

linear metres of newly exposed bare ground; 10% increase in width and depth of ditches, by reference to a 1998 baseline; and 20% increase in dead moss in permanent quadrats. Monitoring of relevant parameters is undertaken by the Centre for Ecology and Hydrology (CEH), who report to site managers who then determine whether or not LAC values have been exceeded. The stakeholder working group meets every spring to review issues, methods, and LAC values. The case study notes some limitations to the method, principally that other parameters which may also be important have not been assigned a LAC value.

46. The above are just some examples that show the wide uptake of the Stankey *et al.* "US" method around the world, including in wetlands. In summary, this method provides a visitor management planning framework which aims to decide how much visitor-induced change is acceptable in a given area. The changes (or impacts) at issue relate as much (and sometimes exclusively) to the visitors' recreational experience as to the ecological conditions of the receiving environment, and are assessed against a background of ultimate objectives framed in terms of recreation outcomes rather than ecological outcomes. While wetland ecological character may be an ingredient in this, it is not a primary or a guaranteed ingredient.

47. This makes the US recreation-based LAC system very different from the Ramsar Convention concept of a set of "ecological character" values acting as tolerance thresholds for the ecosystem. The US system is led by defined values for the "resource condition" (of the wilderness) as the "bottom line" limit that leads the others in the compromise calculation, so there is common cause at least to that extent, but at its core, as discussed above, it is a method for framing compromise between the goals of resource/visitor experience protection and recreational use. It is thus very different from the "signal to noise" distinction being sought in the context of Ramsar Article 3.2. Use of the same terminology in both contexts has caused confusion, and future approaches should try to reduce this.

7. Setting limits: the Ramsar Site management planning guidance

48. The first official use of the term "limits of acceptable change" in the Ramsar context was in the *Guidelines on management planning for Ramsar Sites and other wetlands* adopted in 1993 as the annex to Resolution 5.7 on *Management planning for Ramsar Sites and other wetlands*. It was linked to the idea of staying true to site management objectives, rather than being designed with implementation of Article 3.2 in mind. The reference occurs in a footnote to paragraph 2.4 of the Guidelines, which states:

> The concept of 'limits of acceptable change' is a useful tool, widely used to identify and set limits within which change may be tolerated. It may be applied to the long-term or operational objectives. (Examples for wetlands might be maximum or minimum water levels, or maximum or minimum extent of vegetation). Once these limits are exceeded there will be a need for immediate remedial action. The limits of acceptable change must take account of sustainable yield of natural products, so that harvest rates or fish catches may be determined. Monitoring is implicit and of the greatest importance.

49. The 1993 guidelines drew heavily on the Countryside Management System (CMS) which had been developed a few years previously in the United Kingdom (Alexander, 2000), and which was being revised at the same time as the Ramsar guidelines were being drafted. (The revised CMS was eventually published as Alexander, 2005). This in turn related back to publication in the UK of an earlier management planning handbook for nature reserves (Wood and Warren, 1978).

50. The 1978 handbook had spoken of "specified limits" rather than LAC and embodied an approach that was different from the US one described above, in that it was concerned with specifying the limits for the condition of features beyond which management intervention would become necessary. As Alexander (2008) has explained, somehow the two concepts of LAC and specified limits later became entwined, with some publications (outside the US) proffering definitions of LAC which diverged considerably from the original Stankey *et al.* version.

51. Then in 2000 the CMS Partnership published a guide to the production of management plans for protected areas (Alexander, 2000), which recognised the confusion that had arisen from differing definitions of LAC and consequently reverted to the term "specified limits". This informed the process of drafting the revised global Ramsar guidance which became the *New Guidelines for management planning for Ramsar Sites and other wetlands*, adopted by COP8 in 2002 as the annex to Resolution VIII.14. During that process it was concluded that the proper purpose of LAC was as originally defined in its US context, namely as a framework for managing tradeoffs in relation to recreation-based objectives, and that it was not appropriate to extrapolate from this to contexts of biodiversity conservation, habitat management, and maintenance of ecological character.

52. The *New Guidelines* accordingly removed the previous reference to LAC, and instead they included text on "operational limits" and "specified limits", from which the following are the most salient (abridged) extracts:

> 130. The purpose of operational limits is to define a range of values for each factor which will be considered acceptable and tolerable levels.
>
> 131. The most significant factors provide a focus for surveillance or monitoring. […] Acceptable levels should be defined for any factors known to have a significant impact on the features. For example, it is often necessary to set a level of tolerance for an invasive alien species, which could be anything from total exclusion to accepting the presence of a species providing the population remains below a given limit. Other examples could include biological limits, such as a limit on the extent of scrub cover in wet grassland, and limits on human activities such as hunting or fishing.
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> 132. Operational limits require an upper or a lower limit, or sometimes both. In reality, though, both upper and lower limits are seldom applied to the same factor. Upper limits are usually applied to undesirable factors - they define the maximum tolerance – and lower limits are applied to positive factors.

133. In most instances it will not be possible to set precise, scientifically defined limits. This should not be considered a major issue, however. Operational limits are an early warning system, acting as a trigger for action, reached long before there is any significant threat to the long-term viability of the feature. If scientific information is not available, then professional experience comes into play.

134. Key questions concerning operational limits for factors are:

    i) to what extent can a negative factor be allowed to influence a feature before there is any need for concern; and
    ii) to what extent is it necessary to ensure that positive factors are maintained.

149. Specified limits represent thresholds for action and should trigger an appropriate response. They define the degree to which the value of a performance indicator is permitted to fluctuate without creating any cause for concern.

151. […] iii) when a change has taken place and the reason is unknown, […] establish a research project to identify the cause.

152. Limits for ecological character features should be developed in recognition of the natural dynamics and cyclic change in populations and communities. In reality, there are very few features for which the natural fluctuations are fully understood. For a population, the lower limit might be the threshold beyond which a population will cease to be viable. The upper limit could be the point at which a population threatens another important population, or where a population becomes so large that it compromises the habitat that supports it.

153. Even if a viability threshold is known, it would be very unlikely that a manager would set a limit close to a point of possible extinction. A sufficient safety margin must always be allowed to account for the possibility of unexpected changes or unforeseen impacts. In many ways, limits can be regarded as limits of confidence. When the values of all performance indicators fall within the limits, it can be confidently considered that the feature is at favourable conservation status; when the limits are exceeded, that confidence disappears.

154. Limits for ecological character features may be closely related to suitable use and carrying capacity limits. Thus, limits of human activities/interventions should also be clearly established and monitored.

53. Alexander (2008) uses the same definition of specified limits as in the 2002 Ramsar guidance. In addition he emphasises that the identification of these limits will always require a degree of judgement, backed up by peer review and stakeholder ownership through participatory processes for the approval of management plans. For one thing, it is rare to have robust empirical data on inherent variability from which limits can be directly

derived, as discussed above. For another, conservation objectives relate to desired conditions which may not necessarily be the same as current conditions. Specified limits are thus "primarily value judgements rather than scientifically derived figures".

54. Although the discussion in this section relates to good practice for management planning for Ramsar Sites and other wetlands, it also provides a relevant part of the picture for implementation of Article 3.2. The adoption of a properly-constructed management plan for each Ramsar Site is not a mandatory requirement under the Convention, but it is a strong expectation, and such plans offer perhaps the most logical place for deriving the limits that are relevant to the operation of Article 3.2. Detecting, reporting and responding to change in ecological character ought to relate to management objectives set for the individual site concerned. With reference to the discussion in section 3 above, in the most simplistic sense, anything that falls within the tolerance "bandwith" for the site's management objectives, if they are properly defined, should be "trivial" in the sense of not requiring an Article 3.2 report.

8. Setting limits: early warning indicators

55. At COP7 in 1999 the Contracting Parties adopted Resolution VII.10 on *Wetland Risk Assessment*, annexed to which was a *Ramsar Wetland Risk Assessment Framework*. This Framework includes advice on early warning indicators, and although the Framework does not refer to Article 3.2, the preamble of the Resolution makes clear that that advice was a response to a call from COP6 for the development of such indicators for the purpose of detecting and initiating action in response to change in wetland ecological character, i.e., the Article 3.2 requirements.

56. The Resolution also relates early warning indicators to the management planning context (discussed above) in its paragraph 13, which "Calls upon Contracting Parties to ensure that their preparation of management plans for sites included in the Ramsar List and other wetlands includes, as an integrated element, early warning indicators as part of a monitoring programme based on the framework adopted by Resolution VI.1".

57. The following are the most relevant (abridged) extracts on this issue from the Risk Assessment Framework:

> 14. Monitoring is the last step in the risk assessment process and should be undertaken to verify the effectiveness of the risk management decisions. It should incorporate components that function as a reliable early warning system, detecting the failure or poor performance of risk management decisions prior to serious environmental harm occurring.
>
> 15. The underlying concept of early warning indicators is that effects can be detected which are in fact precursors to, or indicate the onset of, actual environmental impacts. While such "early warning" may not necessarily provide firm evidence of larger scale environmental degradation, it provides an opportunity to determine whether intervention or further investigation is warranted. As such, early warning indicators can be defined as "the measurable biological, physical or chemical responses to

a particular stress, preceding the occurrence of potentially significant adverse effects on the system of interest".

20. […T]he concepts of early warning and ecological relevance can conflict. If the primary assessment objective is that of early detection, then it is likely that it will be at the expense of ecological relevance, while the opposite would probably apply if knowledge of the ecological significance of effects was considered.

21. To have potential as an early warning indicator, a particular response should be: […]

    e) correlated to actual environmental effects/ecological relevance: an understanding that continued exposure to the problem, and hence continued manifestation of the response, would usually or often lead to significant environmental (ecosystem-level) adverse effects; […]
    j) constant in space and time: it should be capable of detecting small change and of clearly distinguishing that a response is caused by some anthropogenic source, not by natural factors as part of the natural background (that is, high signal to noise ratio); […].

34. Acceptance of the need for early warning indicators in a monitoring program implies that information on early change is acted upon and an agreed management plan is in place.

35. Inclusion of early warning indicators in a monitoring program implies a precautionary management approach, that is, intervention before real and important ecosystem-level changes have occurred. Intervention in response to changes in an early warning indicator, therefore, occurs at some conservative and generally arbitrary threshold or trigger value in the measured response.

36. The most powerful impact assessment programs will generally be those that include two types of indicator, namely those associated with early warning of change and those (regarded as) closely associated with ecosystem-level effects. […] With both types of indicators measured in a monitoring program, information provided by "ecosystem-level" indicators may then be used to assess the ecological importance of any change observed in an early detection indicator.

37. Just as for early warning indicators, thresholds of change and other statistical decision criteria for the "ecosystem-level" indicators must also be negotiated and decided upon in advance. Specific decisions on thresholds of change are an issue that can only be dealt with effectively on a site-specific basis […].

58. A fuller treatment of this idea is given in van Dam *et al.* (1999), with a case example of the system employed at the Kakadu National Park Ramsar Site in Australia, which can serve to

illustrate the thinking that informed the Ramsar advice from around the same time; see for example Humphrey *et al.* (1999) and Environment Australia (2002). A large amount of information is now available on early warning indicators worldwide, and statistical methods have been devised for establishing limits in respect of parameters such as water quality.

59. The scope of early warning indicators as defined in paragraph 15 of the *Framework* quoted above might now bear some further thought. One aspect of this is that the definition refers only to biological, physical and chemical parameters, whereas other types of parameters, such as social or economic ones, should probably also be considered. This could especially be the case when considering the trade-off between early warning capability versus ecological relevance, since such social and economic parameters may often provide earlier warning. Moreover, these parameters could in some cases have meaningful ecological relevance, too – for example where an area's human population is declining, or where a fall in local incomes predictably leads to a switch in resource use, there may be predictable (albeit perhaps indirect) relationships between those things and their ecological consequences.

60. The indicator concept outlined in the *Framework* is based on the observable beginnings of actual change in the wetland, hence the reference to "responses to … stress" rather than using indications of the stress itself. It might be thought, however, that where cause-effect relationships are clearly substantiated from past evidence, then "threat" parameters, i.e. proxies and potentialities for actual detriment (such as development approvals or intensification of fishing effort), could also be a valid risk indicator, even when no ecological response has (yet) occurred.

61. The thinking in the preceding paragraph would extend the scope of early warning indicators beyond biological, physical or chemical responses. This would seem to be necessary in any event because of the extension in 2005 (Resolution IX.1 Annex A) of the Convention's previous definition of wetland ecological character (Resolution VII.10, 1999) to include the wetland's ecosystem services (i.e., its beneficial uses and its non-use benefits, e.g., its cultural values). Early warning indicator systems for potential change in ecological character should now therefore include indicators of potential change in delivery of the given wetland's services to people, as well as changes in its biological, physical and chemical attributes.

62. Such early warning of the potential for change is of course distinct from indicators of actual change (not least in terms of thresholds of sensitivity), and it is therefore also distinct from the question of setting limits of acceptable change. There are likely to be points of connection and opportunities for coherence between the two, however, for example in the choice of relevant measurable parameters (at least for those indicators based on the "observable beginnings of actual change", if not for those based on threatened drivers of change). More importantly, as suggested above, operating the two concepts in a linked and mutually supportive way is likely to be the most effective approach (see also section 11 below).

9. Setting limits: waterbird population alerts

63. Although conceptually different from LAC, the waterbird alerts system operated under the Wetland Bird Survey (WeBS) in the UK may have some potential for offering relevant

pointers, and so it is briefly examined here. The alert system arose in response to the need for a scheme for assessing monitoring information that would be consistent yet sufficiently flexible to be integrated with other programmes. It provides a standardised method for identifying the direction and magnitude of changes in waterbird population size at a variety of spatial and temporal scales. Objective thresholds are established against which population trends are assessed, and species that have undergone changes in population size that are sufficient to meet these thresholds can then be flagged by issuing an alert.

64. A key methodological challenge in designing the system was the "naturally-varying baselines" issue discussed in section 4 above. Waterbird populations can fluctuate significantly from year to year, and this can become more marked as the spatial scale of attention decreases. At individual sites, numbers of birds can show very large annual fluctuations as a consequence of a range of factors such as severe weather, disturbance, hunting pressure, or changes in food supply. To be widely applicable, the alert system had to be relatively robust in the face of missing data and of a variable number of sampling events over which population index values (the Underhill Index) are calculated. It also had to be applicable to a wide variety of species showing very different spatial and temporal variations in counts (Atkinson *et al.*, 2006). The solution has been to use Generalised Additive Models (GAM) to produce smoothed indices of abundance which allow assessment of population change from one or more sites or time periods, with any number of estimates of abundance per index period. Changes in index values calculated using these smoothed trends are less susceptible to the effects of short-term fluctuations or to sampling errors than results produced from unsmoothed data.

65. At the species level, "a medium alert" is triggered when a population decline of 25% or more is recorded, and a "high alert" is triggered in the event of a decline of 50% or more. (Additional interpretation of this is required, since different species have different levels of natural fluctuations, so the same level of change for different species gives rise to different real levels of concern). At the site or area level, "medium concern" is flagged when an alert has been triggered for at least one species classed as nationally or internationally important in the site/area, and "high concern" is flagged when alerts have been triggered for 50% or more of such species. Results are presented at different scales. At the site scale (which includes Ramsar Sites), the species for which the site is important are listed, and details are given of any alerts which have been triggered. Figures are provided which allow site trends to be compared with regional and national trends, and analyses for different timeframes (5 years, 10 years, 25 years, and years since designation) allow developing situations to be explored (Thaxter *et al.*, 2010).

66. It has been proposed that the same method could be applied to a wide range of other monitoring schemes for a variety of other taxa (while acknowledging the limitations of using population declines alone to identify conservation concerns, and also noting the relevance of trend persistence, data quality, and other characteristics of the species) (Atkinson *et al.*, 2006). The same authors also note that schemes which monitor large numbers of sites may generate a large number of alerts, leaving policy makers with a need for some additional basis on which to prioritise action. The method also relies on extensive count data over a long time series: WeBS has been running for over 50 years and covers 42 taxa at approximately 2,000 wetland sites in the UK – a degree of data richness which cannot be expected in most parts of the world (although there are statistical modelling techniques which can assist in less data-rich situations).

67. The alerts described above are intended to be used in an advisory way. It is envisaged that, subject to interpretation, they can assist in directing research priorities: the emphasis is on triggering further investigation; but their use in helping to direct conservation response actions is also foreseen. Here then is the potential point of connection with Limits of Acceptable Change. Although the alerts highlight rates of change for different trend periods, and they do not purport to set limits of change in a management context, nonetheless (with appropriate caveats, interpretation and decision rules) a given percentage decline in the population of a qualifying species over a defined period at a Ramsar Site could be chosen as an early warning indicator to be used as described in section 8 above, or could be identified as a threshold of change deemed unacceptable for the site (a LAC), triggering an Article 3.2 report. (The percentage would very likely need to be lower than 25% for these purposes). The statistical trend-smoothing techniques may offer a useful way of standardising analysis of waterbird trends for this purpose, where relevant data exist.

10. Setting limits: the EU Water Framework Directive

68. The European Union's Water Framework Directive (WFD), adopted in 2000, and its daughter Directive on Groundwater (adopted in 2006) aim to prevent deterioration of the status of all bodies of surface water and groundwater in the EU by requiring Member States to prevent deterioration between "status classes" defined for each individual body of these waters (i.e., deterioration of the status of one water body cannot be offset by an improvement of another). (See European Parliament and Council, 2000, 2006, in the References.)

69. The WFD in Article 4.6 provides an allowable exception to the requirement in cases where deterioration is "temporary" and where it is "the result of circumstances of natural cause or *force majeure* which are exceptional or could not reasonably have been foreseen, in particular extreme floods and prolonged droughts, or the result of circumstances due to accidents which could not reasonably have been foreseen, where all of the following [listed] conditions are met". This leaves a question remaining which would appear to be analogous to the Ramsar Article 3.2 question, namely deciding how much change at a site or ecosystem level is "acceptable" before it becomes significant enough to qualify as a real change in terms of the statutory requirement.

70. A large body of technical work has been elaborated on the process of defining baselines and assessing water body quality for the purposes of the Water Framework and Groundwater Directive requirements – see for example the websites of the European Commission (http://ec.europa.eu/environment/water/water-framework/objectives/status_en.htm) and the UK WFD Technical Advisory Group (http://www.wfduk.org/stakeholder_reviews/faq/FrequentlyAskedQuestions).

71. Five water body "status classes" have been defined: high, good, moderate, poor and bad. High status (the reference condition) is defined according to specific parameters for each of a range of ecosystem sub-types, and the other status classes are defined in terms of the degree of deviation from the reference condition: "good status" means a slight deviation, "moderate status" means a moderate deviation, and so on. For surface waters there are two separate classifications: ecological and chemical. For groundwater there are also two

classifications: chemical and quantitative. In each case the overall status assessment also includes hydrological and morphological factors. The status class reported for a water body is dictated by the worst quality element: hence for a water body to be classed as having good status, all of the conditions defining good status must be met.

72. Deterioration in the status of a water body is defined as a decline in any of the elements that make up its status. Deterioration up to the "class limit" of the status assessed as the baseline is permissible for a given water body, but deterioration from one status class to another is not. This does not mean, however, that it is necessarily appropriate, for example, to allow pollutant discharges to take up all the available absorption/dilution "headroom" available within the existing status class of the water body: staged decision-making is advised, and precautionary thinking may be relevant (see section 16 below).

73. Where the water body is already in the lowest status class, no further "significant" deterioration is permitted. A definition of "significant" has not been provided. The UK Technical Advisory Group mentioned above advises as follows: "Usually when making water quality decisions we have assumed more than 10% to be significant" and "In most cases we can allow up to 10% deterioration in the receiving water provided that this will not cause deterioration beyond the class limit". It goes on to say, however, that "in waterbodies which are already in the lowest status class there is a strong argument that any deterioration will undermine efforts to improve the waterbody. Concentrations of pollutants can be high in these waterbodies, which means that allowing an additional 10% is a significant increase in pollutant load. In this case [one should] consider setting permit limits which prevent any deterioration in water quality." One other quantitative threshold is given, namely "For surface waters, no more than 15% of a waterbody (or 1.5km or 15 square km, whichever is the smaller) will be allowed to be in worse condition [i.e., in terms of pollutant load] than the overall status of the waterbody".

74. Further examples of the approach to limit-setting are found in WFD implementation regulations in England & Wales (Defra 2009 a, b). Many pages of environmental quality standards are given as "boundary values" for the different types of rivers, lakes, transitional and coastal waters to which the regulations apply, covering for example dissolved oxygen, pH, salinity, turbidity, concentration of various specific pollutants, etc., and for "ecological quality ratio", indices for biological components such as macrophytes and benthic fauna. Other status indicators and criteria are given for "high hydrological status" (all of which must be met, in order to qualify), including:

    a) the total quantity of upstream abstraction must be less than 5% of the Qn95 flow at the water body outflow point, including non-consumptive abstraction;
    b) the total upstream discharges must be less than 5% of the Qn95 flow at the water body outflow point, including local return of water associated with abstractions and dry weather flows from sewage treatment works;
    c) the total surface area of reservoirs in the upstream catchment must be less than 1% of the total catchment area;
    d) the total area of urban and sub-urban land within the total upstream catchment must be less than 20% of the total upstream catchment area, and the total area of urban land within the total upstream catchment must be less than 10% of the total upstream catchment area;
    e) in relation to a lake water body only, there must be no active management of outflow levels.

75. Breaching these standards takes the water body concerned out of "high status", so it is a threshold of acceptability for that status class. The regulations require the responsible agency (the Environment Agency) to "discount data that are influenced by one-off, unrepresentative or transient incidents, provided that the status of each affected body of water is not adversely affected", and to "estimate and report the level of confidence and precision of the classification results". Again the type of approach operated under the WFD depends on relatively high data and analysis capacities, but the process at least demonstrates that a detailed regime can be agreed in an internationally standardised way, notwithstanding the diversity of ecological and hydrological situations it covers, and some of the thinking here could well be applicable to the operation of Ramsar Article 3.2.

11. Setting limits: LAC in descriptions of Ramsar Site ecological character in Australia

76. The Commonwealth (federal) Government of Australia has developed guidance on issues concerning the ecological character of its Ramsar Sites (DEWHA, 2008), which includes a process for addressing Limits of Acceptable Change. While not necessarily applicable to other Contracting Parties or to other situations elsewhere in the world, this does provide a good example of recent thinking. The Australian system uses a concept of LAC which is defined directly in relation to Ramsar requirements concerning maintenance of ecological character, rather than in the US recreation-management sense: it therefore exemplifies the divergence discussed in section 6 above.

77. The definition of limits of acceptable change adopted in the Australian guidance is "the range of variation in the components, processes and benefits or services that can occur without causing a change in the ecological character of the site", and also "the tolerance that is considered acceptable without indicating a change of ecological character is occurring". It also quotes Phillips (2006) who refers to "the variation that is considered acceptable in a particular measure or feature of the ecological character of the wetland. This may include population measures, hectares covered by a particular wetland type, the range of certain water quality parameter, etc. The inference is that if the particular measure or parameter moves outside the limits of acceptable change this may indicate a change in ecological character that could lead to a reduction or loss of the values for which the site was Ramsar listed". (The final phrase in this quotation is problematic, since Article 3.2 wisely concerns any change in ecological character, not simply changes that might jeopardise the site's qualification for listing. Taking the latter approach could lead to a logical cycle of diminishing returns and is therefore not recommended. Further discussion of this point can be found in paragraphs 19-20 of COP10 Information Document 27 and paragraphs 59-61 of COP9 Information Document 15).

78. In the process of compiling their Ecological Character descriptions (Resolution X.15 and COP11 Draft Resolution 8), wetland managers in the Australian approach would be expected to describe the natural variability (see section 4 above) and limits of acceptable change for each of the "critical" components, processes and benefits/services of their wetland, and to quantify the typical range of variability for the critical components, processes and services and the limits of acceptable change beyond which the ecosystem component, process or service would be expected to move outside the limits specified and result in a change in condition of the wetland. "Critical" components, etc., are defined as those which "most strongly determine the ecological character of the site". This raises

questions about how such a judgement is to be made, and whether LAC thresholds set at such a level will be sensitive enough, but the guidance does not elaborate further on these points.

79. The 2008 guidance further provides that:

- The limits of acceptable change may equal the natural variability or may be set at some other value. Justification for the limits should be provided.

- Where possible, the limits of acceptable change should be based on quantitative information from relevant monitoring programmes, scientific papers, technical reports, or other publications and documented information on the wetland. Wetland experts, indigenous leaders and oral histories may also provide information that can be useful in setting limits of acceptable change. In some cases the datasets may not be ideal, although they may contain enough information to set interim limits of acceptable change and identify the need for further data.

- For some components, processes or wetlands, there may be very little information available. Where available information is not comprehensive enough to set definite limits or interim limits of acceptable change, this lack of information should be described as a knowledge gap. Where possible, the information required to set the limits should be identified if that information is not available.

80. Examples of the types of limits suggested include:

- significant loss of area (advice required on what constitutes "significant");
- any net reduction in waterbird numbers over 10 years;
- an observed, estimated, inferred or suspected reduction of waterbird species of 10% or more over 10 years;
- any net reduction in native fish populations over 5 years;
- more than 20% change, sustained for more than two years, in the number of species of any of the classes of macroinvertebrates present;
- more than 12% loss of species or taxa of any of the classes of invertebrates present over 5 years;
- more than 4% mortality rate of grey mangroves over 1-2 years under stable climatic conditions;
- loss of up to 90% of grey mangroves due to flooding or cyclone in 1-2 years;
- loss of up to 90% of sedges and saltmarshes in 1-2 years due to flooding or cyclone;
- more than 5% change in area of sedge and saltmarsh community over 10 years;
- site specific trigger values (once sufficient data has been collected) based on 80th percentile of median water turbidity values;
- any significant change in median turbidity levels from baseline, over 10 years;
- any significant change in median salinity concentrations from baseline, over 10 years.

81. The guidance further advises that the ecological character description should include information on sources of information and on any identified knowledge gaps. It notes that

use of the LAC concept requires good knowledge of natural variations, and it says that "where this is lacking, the precautionary principle will be applied" (see section 16 below).

82. In October 2009 the relevant department (DEWHA) held an internal workshop to review experiences thus far with LAC and with ecological character descriptions (ECD) for Australian Ramsar Sites. A summary of key points arising has been shared with the Ramsar STRP (I Krebs, *pers comm*) and is reproduced below:

- Through the development of ECDs there has been some confusion over the difference between a LAC and a management trigger. Management triggers represent smaller/earlier change points within a range of variability bounded by LAC. The challenge for Australia in drafting ECDs has been to ensure that LAC set the boundaries of ecological change that can than be used to develop management triggers that will inform management plans. Management decisions based on management triggers should influence the management outcome and so it follows that management triggers should be included in a management plan, not in an ECD.

- Various terms have emerged to describe and qualify LAC, for example "interim LAC", "early warning LAC", "optimum LAC". This additional qualifying terminology is leading to confusion and a lack of consistency between ECDs. LAC should simply be referred to as "limits of acceptable change".

- Where it is necessary to qualify a LAC due to levels of confidence pertaining to availability of data, for example, it is suggested that rather than doing this through labels or new terminology, this should be provided in qualifying statements. Australia is pursuing a model in which LAC are accompanied by an indication of confidence for the LAC. Indications of quality (e.g., site specific data of sufficient quality and quantity to determine statistically valid LAC; site specific data of lesser quality; expert opinion; information from literature for similar systems), and the data sources should be included to give confidence and define the arguments for the LAC. Referencing and data sources need to be clearly recorded against each LAC.

- Direct measures should be used for LAC. In some cases where there is no direct data available for a LAC (for example, the number of individuals of a species using the site), it may be possible to have indirect measures identified against the critical components, processes and benefits and services (CPS), provided they adequately represent the critical CPS of interest and can be justified.

- In many cases the activity that can impact on a critical component, process or service, and potentially lead to an exceeded LAC, occurs outside of the Ramsar Site, and therefore cannot be managed by the site manager. In these cases a LAC still needs to be set for this critical element. Article 3.2 assessment would determine the cause of the exceeded LAC, and then determine whether a notification is required.

- LAC for ecological character descriptions are to be identified for the time of listing of the site under the Ramsar Convention. This may pose challenges in some cases, but wherever possible LAC should be set at the time of listing.

- In the case of some Ramsar wetlands, the system was already declining when the site was listed, sometimes as a result of activities (for example, land clearing) that were undertaken decades prior to listing, and the site will continue to degrade as a result of past activities. Other sites have been actively managed or restored since listing, and setting LAC at the time of listing would theoretically mean we are trying to maintain a wetland in poorer condition than the current condition. If it is recognised that there is a new stabilised state that differs from the condition at the time of listing when writing ECD, then a solution […] would be to provide the LAC at the time of listing in the LAC section [of the ECD] and then provide a second set of LAC reflecting the new stabilised system in the "change in ecological character since listing" section of the ECD, or as an appendix to the ECD.

- There has been considerable variation in the number of LAC presented in draft Australian ECDs to date, ranging from three to over 80. That said, the unique character of a site should determine the number of LAC.

- It is desirable to limit repetition of LAC for a site. This can be achieved by the development of a flow hierarchy (or cascading LAC) for the site, i.e., LAC are first developed for components, then processes, and finally services (CPS). For example, if a LAC identified for a component is found also to cover a process or a service, then [a separate] LAC for the process or service may not be required. A LAC is normally required for all identified critical CPS, unless the particular CPS was already picked up earlier. In such cases, reference to the existing LAC should be made. This will mean that many services at the end of the flow hierarchy may not require a specific LAC as they will have been addressed earlier in the LAC for components and/or processes, i.e., the particular components and processes that enable the wetlands to provide particular services. However, these relationships must be made clear in the ECD.

- Critical CPS can be identified for different parts of the Ramsar Site and, as a result, LAC can be set for a subset of the site. Even when the wetland systems are connected within the site, LAC can be set for part of the system noting the location and area of the site that the LAC applies to. In these cases the critical CPS relating to the entire site will usually have site level LAC, whereas the critical CPS relating to part of the site would have LAC relating to that part of the site. A breach of a LAC in part of a site would still be considered a potential change in character for the whole site for the purposes of the ECD, and an Article 3.2 assessment may be considered under Australian national guidelines on Article 3.2 notification [DEWHA, 2009].

83. An Australian example, the Murray-Darling Basin, is addressed by Pittock *et al.* (2010), who discuss the added complexities of climate change and refer to the Murray Darling Basin Plan which is required (under the Water Act 2007) to set long-term average sustainable diversion limits for water that may be taken from the Basin as a whole and for each water resource management area within the basin, and which "must reflect an environmentally sustainable level of take".

84. The authors emphasise the importance of giving reasons for the setting of all conservation objectives, limits and thresholds. They describe the red gum stand condition categories

defined for the site, and the management objectives that are defined in terms of the percentage of the vegetation area which should be considered as in a healthy state, or good condition. A threshold is then proposed for determining change in ecological character of floodplain Ramsar Sites, to the effect that a change of 10% in the area of any of the constituent ecosystems should be regarded as "critical" for the purposes of the national guidance described above.

12. Setting limits: Thresholds of Potential Concern for wetlands in South Africa

85. In South Africa, "Thresholds of Potential Concern" (TPC) are used to assess and respond to changes in wetland condition, by reference to defined quality objectives. Analogies can be drawn between these TPCs and limits of acceptable change for ecological character in the context of Ramsar Article 3.2.

86. A system known as "WET-Sustainable Use" has been developed to assist in assessing the ecological sustainability of wetland use, based on three generic management objectives (biodiversity conservation, catchment water quality management, and livelihood support), related to five of the key elements that determine a given wetland's environmental condition (Kotze, 2010). The approach asks to what extent the use of the wetland has affected the five elements, and scores this for each of them from 0 (no impact) to 10 (critical impact). TPCs are defined in terms of these scores for each objective in relation to each key element, through a process that includes stakeholder dialogue. An example is shown below (adapted from Kotze, 2010):

	Biodiversity conservation	Catchment water quality management	Livelihood support
Hydrology: distribution and retention of water	>1	>2	>4
Retention or erosion of sediment	>2	>2	>3
Accumulation of soil organic matter (SOM)	>2	>2	>3
Retention and internal cycling of nutrients	>2	>1	>3
Natural vegetation species composition	>2	>6	>5

87. The thresholds, defined along a continuum of change, establish what are considered to be the limits of sustainable use for a given wetland, tailored to the specific management objectives and circumstances of the site (the three objectives shown above are provided merely as a generic starting point). In the example shown above, the threshold relating to impact on vegetation composition is more stringent for a primary objective of biodiversity conservation than for a primary objective of water quality, whereas in respect of the thresholds relating to impact on nutrient retention, the reverse is the case. A rationale for these choices is documented for each threshold. An alternative to using elements determining wetland environmental condition could be to set thresholds for indicators of these elements: so for example "frequency of tillage" could be an indicator of accumulation of SOM, and "tilling more than once a year" could be the TPC. Several indicators could be relevant for each element of condition, and the choice of which to use (and how they interrelate) would need care.

88. TPCs are treated as hypotheses that are adjusted as new learning develops. When assessment indicates that the threshold has been exceeded or is close to being exceeded, this highlights the need for specific management intervention and/or further investigation. The process has more recently been incorporated into a procedure for determining Resource Quality Objectives (DWA, 2011; D Macfarlane, *pers comm*), in which both upper and lower thresholds may be set to "hypothesise the limits of acceptable change in ecosystem structure, function and composition", to provide early warning of deviation from a desired level, and to define boundary conditions within which adaptive management should operate.

89. In the Resource Quality Objective system, Numerical Limits are set to represent the "worst" level of a desired parameter. TPCs should be set at a point before this level is reached. Depending on the nature of the environmental indicator, it may be necessary to set either an upper or lower TPC, or both. For example, if the indicator relates to allowable fishery take, concern should be triggered at a figure set in relation to the maximum, but there is no need to define a minimum. If on the other hand the measure is size of catch as an indicator of the health of stocks, then numbers that drop too low would trigger concern, but there is no need to define a maximum. If a Numerical Limit has been set for pH as part of the optimal habitat conditions for the fish, then both upper and lower thresholds will be required.

90. The proximity of the TPC to the Numerical Limit is determined by the degree of confidence in the data. Where the Numerical Limit is based on reliable data and is felt to be fairly accurate, the TPC can be set relatively close to the Numerical Limit; otherwise it should be set at a significantly "better" level.

13. Situating the definition of LAC for sites in relation to relevant Ramsar information frameworks

91. The discussion and examples presented above have been related to more than one part of the Ramsar implementation process, and there are other parts which have not yet been mentioned. This section identifies the main places in the Convention's information frameworks where the definition of limits of acceptable change (or analogous definitions) for sites can appropriately be situated.

92. The first is the baseline **description of ecological character** of a Ramsar Site. Relevant organising frameworks for this information have been provided in the Information Sheet on Ramsar Wetlands (RIS) (currently in Wise Use Handbook 17, along with guidance on its use); and the Ecological Character Description (ECD) Sheet (currently in the annex to Resolution X.15). Resolution X.15 also presents a revised version of the core fields for wetland inventory which were first adopted in the annex to Resolution VIII.6.

93. These three documentation frameworks have an "inventory" purpose, i.e., to record the values that are of interest at a site in a consistent and comparable way across the global List of Wetlands of International Importance recognised by the Convention. They also have a function as the basis for reporting non-trivial changes or likely changes in ecological character as required by Article 3.2. The annex to Resolution X.15 suggests using the ECD sheet as a simple pro-forma for such reports, and also suggests that "Parties and wetland

managers may wish to add, where appropriate and possible, […] a further column identifying limits of acceptable change, where defined". The three frameworks have been updated in a more integrated way for the future in Annex 2 to COP11 Draft Resolution 8. Definitions of limits of acceptable change should feature in the proper completion of site information in this integrated framework, by reference to the elements of ecological character described for each site.

94. The second relevant place for defining limits is in **site management plans**. While the most important consideration in defining limits as part of ECD is to relate them to the elements of ecological character, the most important consideration in defining them in a management plan is to relate them to management objectives.

95. In a generic sense, by default every Ramsar Site has an objective of "maintaining the ecological character of the wetland", but this will normally be broken down into a number of constituent sub-objectives, and limits of acceptable change can be attached to each of those. Although the same description of limits could be used in both the ECD and the management plan (organised according to the individual elements of the site's ecological character), many managers will wish to take the opportunity in the management plan to arrange the information differently and to expand on links to the adaptive responses that should be triggered when limits are approached or breached. (It should go without saying, however, that the plan and the ECD must be consistent with each other).

96. Once defined, as well as their use in relation to Article 3.2 reporting and the implementation of management plans, limits of acceptable change may also prove a helpful element of processes for wetland **risk assessment** (see the Ramsar wetland risk assessment framework annexed to Resolution VII.10). As COP11 Daft Resolution 9 points out, a "risk-based approach" will involve not only the assessment of the magnitude and likelihood of risks (covered by Resolution VII.10), but it is also a way of making explicit the chosen levels of risk which can or cannot be tolerated in given circumstances. Limits of acceptable change are one way in which this "risk appetite" can be expressed. Conversely, it will often be appropriate to describe the rationale for chosen limits of acceptable change in terms of risk appetite, especially where it is not possible or appropriate to set fixed quantitative thresholds. (See also the discussion on precautionary approaches in section 16 below.)

97. Defined limits of acceptable change may also prove helpful in interpreting the results of **Environmental Impact Assessments** (see the guidance annexed to Resolution X.17).

98. As we have seen, the decision (informed by limits of acceptable change) that a change in ecological character has occurred, is occurring or is likely to occur will normally prompt not only the reporting of this fact under Article 3.2, but also a potential range of **management and/or policy responses** to the change. Ramsar decision-support frameworks for the responses that may follow are presented in the annex to Resolution X.16 (*A Framework for processes of detecting, reporting and responding to change in wetland ecological character*), expanded further in the background document COP10 Doc. 27, and in the annex to COP11 Draft Resolution 9 (*An Integrated Framework for avoiding, mitigating and compensating for wetland losses*). These both hinge fundamentally on the initial description of what is at stake (ECD) and on the identification of change. LAC (in the Ramsar Article 3.2 sense) therefore feeds directly into this latter step in these Frameworks.

14. How much (minimum) definition of limits is expected?

99. Some of the approaches described above operate with substantial volumes of accumulated data and with well-resourced management agencies. These offer an instructive indication of what may be possible, but they clearly would not be immediately translatable to many other more capacity-constrained parts of the world. It is obviously difficult to define acceptable limits for a phenomenon if its potential impacts are unknown or unpredictable, especially where effects are not linearly related to causes, and where for example one increment too far may provoke a catastrophic shift (see, e.g., Beisner *et al*., 2003 and Gordon *et al*., 2010). In terms of the global application of Ramsar systems, therefore, any standards or guidance which may be developed on this issue will need to recognise such capacity constraints, while at the same time giving good direction for those countries that already have intricate delivery mechanisms.

100. One approach to this would be to set out general "framework" principles which could be applicable anywhere, and otherwise to leave more detailed aspects to national discretion. This would need to be weighed against the risk of divergent and potentially contradictory approaches developing in different places. It also may not provide sufficient help for countries wanting guidance on how to develop in the right direction. It further may not satisfy the needs of those Contracting Parties where cutting-edge conceptual challenges are being put to the test, potentially in arenas of legal dispute where the financial and political stakes are high, and where a global reference framework and some leadership from the Convention might be expected.

101. An alternative approach would be to provide advice in a "tiered" form, establishing the minimum basic expectations, and then offering layers of progressively more developed guidance on approaches that are recommended, subject to the requisite levels of capacity. (In every case, of course, the actual limits themselves will be specific to the circumstances of an individual site: although case examples can be listed, and a range of possibilities provided, it would be no part of global advice to attempt to prescribe the specifics of what the limits should be in any given instance).

15. A further issue: the "likelihood" of change

102. The text of Article 3.2 was far-sighted in requiring formal communication not only about those site changes that have happened or are happening, but also about those deemed "likely" to happen. This allows anticipatory/preventive action, which is usually the wisest and most cost-effective kind.

103. No guidance has been given on what degree of "likelihood" or confidence is sufficient to require the triggering of the Article 3.2 process. Clearly it would defeat the aim of this provision if strict standards of evidence, substantiation and quantified probabilities were imposed. On the other hand, the system might be open to abuse (or at least ineffectiveness) if the merest suggestion or anxiety on the part of one person were enough to create the legal reporting obligation. The appropriate approach lies somewhere in a middle ground of informed, authoritative or expert judgement.

104. Further guidance on this may be desirable in future. This could include the question of which types of indication of likely change are legitimately within scope, such as plan-making and decision-making processes which may reveal a prospect or proposal for change (see paragraph 60 above). It could also include advice on determining and applying degrees of confidence and confidence limits. There is a logical link to the question of what approach to take in conditions of uncertainty, and this is discussed in the next section.

16. Erring on the side of caution, when precise information for setting limits is lacking

105. Resolution VIII.8 (2002) on *Assessing and reporting the status and trends of wetlands, and the implementation of Article 3.2 of the Convention* encouraged Contracting Parties "to take a precautionary approach" to these issues while the STRP was preparing further advice. This ethos of "precaution" logically also has an enduring role to play in the overall scheme.

106. Standards and international thinking on the concept of precautionary approaches are now in common currency. As one example, the concept is written into the text of the Convention on Biological Diversity (preamble paragraph 9). As another, IUCN has produced Guidelines for applying the precautionary principle to biodiversity conservation and natural resource management (IUCN, 2007).

107. In the context of detecting, reporting and responding to change in ecological character, it could be argued that the text of the Ramsar Convention (in requiring a response to "likely" change) has always embodied an aspect of the precautionary approach, long before it became the widespread principle it now is elsewhere.

108. Section VI of Ramsar Handbook 18 on *Managing Wetlands: Frameworks for managing wetlands of international importance and other wetland sites* (4th edition, 2010) concerns "The precautionary approach as applied to environmental management", and contains the following:

> 54. When considering the carrying capacity of a site for any human use, activity or exploitation (i.e., its sustainability), the best available evidence should indicate that the activity will not be a threat to the features of the ecological character of the site.
>
> 55. Contracting Parties are, when implementing their wetland management planning process, invited to take into consideration the precautionary approach, as established in Principle 15 of the 1992 Rio Declaration on Environment and Development adopted by the United Nations Conference on Environment and Development (UNCED), which affirms that:
>
> 'In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.'

109. These considerations could all be particularly important to the process of attempting to define limits of acceptable change for the purposes of Article 3.2, given that it is an inherently predictive process and there will rarely be absolute certainty about (for example) the reversibility of a change that is deemed to be temporary. Further work on codifying the application of a precautionary approach in this context may be desirable in future.

17. Elements of potential further work by the STRP

110. Some elements of relevant further work have already been identified in existing or rolled-forward tasks for the Scientific and Technical Review Panel (STRP), which together with points arising from the present paper are likely to feature in the Panel's work programme for the coming triennium (2013-15). A task has been proposed on rationalisation of Article 3.2, as a development of tasks initially defined by COP10 for the 2009-12 period, and on which little progress was made in that period. The 2009-12 tasks have been more appropriately redefined so as to lead to a more rounded and coherent update and rationalisation of guidance on issues relating to Article 3.2. Aspects of this that are relevant to the current LAC discussion would include:

- information and guidance on approaches to establishing the range of natural variability of wetland sites (building on the present paper, and potentially providing guidance on methods, i.e., beyond simply documenting ranges of known values for a suite of indicators for each site);
- information and guidance on approaches to defining Limits of Acceptable Change (building on the present paper);
- consideration of the need for and scope of guidance on determining confidence limits and degree of likelihood in cases of "likely" change in the context of Article 3.2; and
- consideration of the need for and scope of guidance on the application of a precautionary approach in the Ramsar Convention.

18. Conclusions and recommendations

111. The present paper has given a broad overview of existing approaches and other considerations concerning the definition and operation of concepts and approaches for "limits of acceptable change" which may be applicable to the specific Ramsar context of defining and detecting change in the ecological character of wetlands. It does not purport to give formal guidance; rather, it should provide helpful background for those responsible for implementing relevant parts of the Convention. Two recommendations are highlighted below.

112. The task which served as the basis for this paper may have been framed in the wrong terms. It is evident that the phrase "Limits of Acceptable Change" (LAC) has been used in significantly different ways in different contexts, giving rise to some confusion and mistaken conceptual extrapolations. Since the Ramsar usage developed subsequent to the US recreation management usage, it would be advisable to adopt different terminology for defining how much change constitutes relevant change for the purposes of Article 3.2. (The same conclusion was reached in relation to the Convention's site management planning guidance by the drafters of the guidance adopted at COP8 in 2002, but until now this has been mostly overlooked in discussion of Article 3.2). **For Article 3.2 purposes,**

therefore, it is recommended that the term "Limits for Defining Change in Ecological Character" (LDCEC) should be used instead.

113. The present paper has identified different purposes for LAC in the context of specific existing Ramsar information management and decision-making frameworks. It has also highlighted various conceptual distinctions between recreational management compromise protocols, precautionary envelopes for ecosystem status reporting, early warning indicators, benchmarking the range of normal variability, adaptive management triggers, expressions of risk appetite, interpretations of "trivial" change, and degrees of approximation/tolerance bandwidths for the achievement of conservation objectives.

114. Some deeper issues may also be involved, such as the longer-term (culturally and sociologically-determined) evolution of issues such as perceptions of risk, acceptability of detriment, and our language for the values we place upon the environment.

115. It could be argued that the question may be the wrong one on an even more fundamental level than simply the terminological issues referred to above. Bridgewater (2008) argues (in the context of the Ramsar rubric on maintenance of ecological character) that ecosystems inevitably change: they process energy, nutrients and information to evolve in a more complex and apparently more stable direction; yet while they so do, Earth-scale change processes slowly re-define the contextual conditions, so that even "stable" or "climax" ecosystems are simply steps in a continuing progression. While it is therefore understandable that Ramsar requirements have been written in terms of human-scale comprehension of the space and time parameters of ecological processes, striving at specific sites to fix these parameters within hard tolerance limits may not reflect the underlying reality.

116. Bridgewater goes on to argue that change in this sense could be embraced rather than automatically resisted, through assessment and reporting processes which add to our understanding of wetland ecosystem functioning, to inform future policy development, decision making and priority setting under the Convention, including the management of Ramsar Sites. Hence maintenance of (or prevention of change in) ecological character might not be the most appropriate measure of success in managing these sites.

117. Persuasive though these arguments might be, Contracting Parties are committed to implementing the requirements of the Convention as they stand. They are rightly obliged to guard against unwanted deterioration of wetland resources for unjustified reasons, and the dangers of abuses of any perceived "laissez faire" "change embracing" approach are obvious. The challenge of distinguishing unwarranted and unwanted change from inevitable and "natural" change remain, as do the challenges of distinguishing meaningful change from "trivial" change.

118. The present paper has shown some examples of how these issues may be navigated, and has mapped out at least some of the scope of potential future work on the subject. **Such work is recommended in the next triennium** to build on this review and to offer focused guidance, mindful of the differing capacities which exist.

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