CONVENTION ON MIGRATORY SPECIES

Distribution: General

UNEP/CMS/COP12/Doc.24.4.3
25 May 2017

Original: English

12th MEETING OF THE CONFERENCE OF THE PARTIES
Manila, Philippines, 23 - 28 October 2017
Agenda Item 24.4.3

CONSERVATION IMPLICATIONS OF ANIMAL CULTURE AND SOCIAL COMPLEXITY

(Prepared by the Culture Expert Group of the Scientific Council and the Secretariat)

Summary:

Resolution 11.23 requested the Scientific Council to establish an Intersessional Working Group on the conservation implications of culture and social complexity. Following guidance from the First Meeting of the Sessional Committee of the Scientific Council, this Expert Group has continued developing its report and conclusions, and has made recommendations for further work (see report in Annex 1). These recommendations have been transcribed to the Draft Decision presented in Annex 2.

Implementation of the Resolution and draft Decisions will contribute towards meeting target 15 of the Strategic Plan for Migratory Species 2015-2023.

This document should be read in conjunction with document UNEP/CMS/COP12/Doc.21.1.32 concerning resolutions to be repealed in part.

CONSERVATION IMPLICATIONS OF ANIMAL CULTURE AND SOCIAL COMPLEXITY

1. Resolution 11.23 on Conservation Implications of Cetacean Culture adopted at COP11 (UNEP/CMS/COP11/Resolution 11.23) requested the Scientific Council to establish an intersessional expert working group to address the conservation implications of culture and social complexity, with a focus on, but not limited to, cetaceans.

2. The Resolution invited relevant CMS Scientific Councillors for taxa other than cetaceans to review the findings of the Workshop on the Conservation Implications of Cetacean Culture (UNEP/CMS/COP11/Inf.18) and engage in this expert group.

3. In June 2015 external experts nominated by the Scientific Council were invited to join. As of 31 May 2017, 47 scientists of various backgrounds were members of the expert group, with the following expertise:
   - nineteen cetacean experts, with a special focus on cetacean culture, social structure, social learning, communication and cultural transmission, demographics, links between genetics and culture, behaviour, disturbance and its population consequences, and ecology;
   - eight bird experts, with a special focus on bird communication, social structure, evolutionary, ecological and social contexts of tool use, social learning and habitat fragmentation;
   - four elephant experts, with a special focus on social structure, matriarchs as knowledge repositories, and cognition;
   - four primate experts, with a focus on behaviour and culture;
   - two reptile experts, with a focus on social learning;
   - ten experts with other related expertise, such as ecology of information use, social evolution and biodiversity, phylogenetic approaches to culture in humans, culture in non-humans, birds and mammals, and related policy.

   Collectively, the experts are affiliated to more than twenty different universities and research institutes, as well as a number of governmental scientific facilities and scientific associations.

4. Resolution 11.23 further requested the expert group, subject to the availability of resources, to:

   a) develop a list of priority species listed on the CMS Appendices for a comprehensive investigation of culture and social structure and commence more detailed analysis as appropriate, including for example developing a list of key factors that should be taken into consideration for effective conservation; and

   b) report its findings and any proposals for future work through the Scientific Council to CMS COP12.

5. Following its report to the Sessional Committee of the Scientific Council (UNEP/CMS/ScC-SC1/Doc.10.4.1), the Expert Group continued its deliberations, the results of which are presented in Annex 1 to this document (including a full version containing references and the two case studies developed is available as UNEP/CMS/COP12/Inf.14). The report also contains recommendations for further work on this subject, which are presented in the draft Decision in Annex 2 of this document. Furthermore, a related Concerted Action for the eastern tropical Pacific population of the Sperm whale is being proposed and can be found under agenda item 26.

Resolution 11.23

6. As part of the process outlined in UNEP/CMS/COP12/Doc.21, one paragraph of Resolution 11.23 has been proposed to be converted to a Decision, as contained in Annex 2 of UNEP/CMS/COP12/Doc.21.1.32. This draft decision has been carried forward into Annex 2 of the present document, where additional decisions have also been proposed.

Recommended actions

7. The Conference of the Parties is recommended to:

    a)   note the report contained in Annex 1 of this document;

    b)   adopt the Decisions contained in Annex 2.

<div align="right">**ANNEX 1**</div>

**INTERSESSIONAL REPORT OF
THE CMS EXPERT GROUP ON CULTURE AND SOCIAL COMPLEXITY[1]**

1. Introduction

Resolution 11.23 on Conservation Implications of Cetacean Culture adopted at COP11 (UNEP/CMS/COP11/Resolution 11.23) requested the Scientific Council to establish an intersessional expert working group to address the conservation implications of culture and social complexity, with a focus on, but not limited to cetaceans.

The resolution invited relevant CMS Scientific Councillors for taxa other than cetaceans to review the findings of the Workshop on the Conservation Implications of Cetacean Culture (UNEP/CMS/COP11/Inf.18) and engage in this expert group.

In addition, the resolution also requested the expert group, subject to availability of resources, to:

1) develop a list of priority species listed on CMS for a comprehensive investigation of culture and social structure and commence more detailed analysis as appropriate, including for example developing a list of key factors that should be taken into consideration for effective conservation; and

2) report its findings and any proposals for future work through the Scientific Council to CMS COP12.

This document is the report of the discussions of the expert group, with recommendations for future work for the Scientific Council to consider.

1.1 Definitions
During the discussions of the expert group, the following definitions of culture and social complexity were agreed to be the most relevant to CMS deliberations:

Culture:
Information or behaviours that are shared by a community and acquired through social learning from conspecifics, that are exhibited with a degree of temporal stability.

Social complexity:
Although a common understanding of the term 'social complexity' was applied during the April 2014 workshop, no official definition was agreed. A simple definition was suggested on the workspace:

Individuals possess diversity in number, type and quality of social relationships with other members of their population: the more diverse these social relationships, the more complex the society. In the most socially complex species, individuals interact with many different conspecifics, in different contexts and these relationships are often long-term, well differentiated, highly cooperative and/or competitive.

Further clarification of the different 'types' of social relationship referred to in this definition was discussed. Whiten's dimensions of social complexity (Whiten, 2000) were considered useful in providing guidance. His dimensions of social complexity include: the level of social structure, dyadic and polyadic complexity, as well as variability of response, instability, complexity of prediction and demographic complexity (see Appendix I).

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[1] a full version containing references and the two case studies developed is available as document UNEP/CMS/COP12/Inf.14

1.2 Methods

The group considered examples where social information use, social learning and resultant cultures may be important to conservation, across a range of taxa relevant to CMS. It was necessary to adopt some common rules for delineating culture as a major driver of behaviours. The method of exclusion was utilized by the 2014 workshop participants. This process was described thus: "*The study of non-human culture has traditionally used the 'method of exclusion' by which culture was inferred as behind a behavioural pattern if genetic causation, ontogeny, and individual learning in different environments could be excluded. Excluding causes is logically and practically troublesome, and cultural variants are bound up with genetic patterns in matrilineal societies, and with ecological variation for foraging behaviour. Thus new methods that apportion behavioural variation to genes, environment and culture are being developed and used*" (Luke Rendell, abstract submitted to April 2014 workshop) (CMS, 2014). Acknowledging this final point, the expert group agreed that this field of research has now developed beyond singular reliance on the method of exclusion. Therefore, to avoid the limitations of this method, the expert group agreed that it will be more productive to keep track of emergent complementary techniques, such as fine-scale studies of individual behaviour (e.g. using remoting sensing), field experiment or large-scale genetic studies.

Rendell and Whitehead presented a draft working paper to the April 2014 Workshop entitled 'Towards a Taxonomy of Culture'. In this document, they identified a number of cetacean behaviours which they categorized as 'definitely', 'likely' or 'plausibly' cultural, chosen according to the strength of evidence for social learning. These behaviours were then further classified according to: taxonomy; mode of transmission; extent of shared behaviour; behavioural domain; persistence and conservation implications. Notably, evidence for cetacean culture was found in the following behavioural domains: communication, foraging, habitat use/migration and arbitrary/play. Thus, extensive potential for interactions between cetacean culture and conservation were identified.

It is suggested that, for a number of key species of relevance to the conservation work of CMS, developing a similar taxonomy of culture across these other taxa may be useful in identifying priority species.

2. Evidence from across taxa

Examples of social learning, social complexity and potential culture were discussed from a range of taxa including birds, mammals and reptiles.

2.1 Social Learning

Following on from the 2014 workshop, the expert working group discussed social learning in a range of taxa potentially relevant to CMS. Examples of social learning were provided from a wide range of species as diverse as whales, elephants, birds, fish and lizards. In addition to the extensive discussions on social learning and culture in cetaceans during the 2014 workshop, some further areas of discussion arose and are summarised here.

Mammals

Elephants

It was noted that although social learning has rarely been systematically investigated in wild African elephants (*Loxodonta africana*), there is evidence that knowledge transfer does occur between experienced and naïve individuals in the context of oestrus behaviour (Bates et al., 2010). It was further noted that there is currently only scant research on whether information passes between generations via culture in this species, although experienced matriarchs do influence the behaviour of their groups in the context of social knowledge and knowledge of predators (McComb et al., 2001, 2011). A recent analysis also suggests routes to preferred locations are maintained as traditions within families (Fishlock et al., 2015). A new piece of research is now underway (by Bates and McComb) to examine patterns of social behaviour in different elephant populations across Africa to investigate directly whether elephants show evidence of having cultural traditions. Nevertheless, the role of matriarchs as repositories of social knowledge and evidence that the age of the matriarch can influence reproductive rates

of younger females in their social group (McComb et al., 2001) remains highly relevant to their conservation.

Gorillas
Gorillas live in a range of different habitats, have diversity in their social structure (Caillaud et al., 2014) and exhibit a range of foraging and other behaviours, within and between geographic locations. Using the 'method of exclusion', investigations into evidence for potential cultural traits within the two species of gorillas suggest that significant variation between and within five habituated populations of western and eastern gorilla populations warrants further research to determine if some of these behavioural traits are influenced by social learning. Of the 41 behaviours investigated, 23 met the criteria of 'potential cultural traits', of which one was foraging related and nine were environment related (Robbins et al., 2016).

African wild dogs
Research on a 25-year dataset on re-introduced African wild dogs (*Lycaon pictus*) in South Africa which described population and pack dynamics showed that behavioural factors associated with the sociality of this species had been limiting the recovery of this population, rather than ecological factors such as the amount of rainfall, available prey, or the number of competitors (Somers et al., 2008). Sociality can therefore influence the vulnerability of small populations to extinction, particularly where there is a low probability of finding suitable mates. As obligate co-operative breeders, species such as African wild dogs may be particularly vulnerable at low population densities (Courchamp et al., 2000). However, it has further been suggested that the group level structure of cooperative individuals and their behaviour within these groups may diminish some of the extinction risks associated with these small groups, further highlighting the need to explore the relationships between group living and extinction risk (Angulo et al., 2013).

Other mammals
In addition to the mammals discussed here and the cetacean species discussing during the 2014 workshop (CMS, 2014) there are a number of other mammalian species that exhibit social learning which may be broadly relevant to the work of CMS. These include bats (Ratcliffe et al., 2005; Wright et al., 2011) and mustelids (Thornton, 2008; Thornton and Malapert, 2009; Müller and Cant, 2010). For a review of social learning in mammals see Thornton and Clutton-Brock (2011).

Birds
Social learning is important for birds, across species and functional contexts. Avian song dialects are arguably amongst the best-documented cases of animal cultures, and even include examples with conclusive evidence of cumulative cultural processes (Slater, 1986; Kroodsma, 2004; Catchpole and
Slater, 2008). In a non-vocalisation context, evidence for social learning, and stable between-group differences, is considerably scarcer.

Given that the remit of CMS is the conservation of migratory species, it was suggested that a key piece of research to consider is the study on social learning of migratory performance in whooping cranes (*Grus americana*) (Mueller et al., 2013). The authors report evidence that social learning affects cranes' migratory performance, with social learning from older birds reducing deviations from a straight-line path and seven years of experience yielding a 38 per cent improvement in migration accuracy (see Appendix II).

Further, within the context of foraging, there is compelling experimental evidence that great tits (*Parus major*) can develop stable, socially-transmitted foraging traditions (Aplin et al., 2015; and see subsequent papers). Similarly, experimental research on blue tits (*Cyanistes caeruleus*) found strong evidence that individuals can use social learning to acquire novel foraging skills (Alpin et al., 2013). This suggests that 'cultural' variation may be much more widespread amongst birds than previously understood. A well-cited avian example of possible cultural variation in foraging techniques is the (non-migrant) New Caledonian crow (*Corvus moneduloides*), which has been shown to use a diversity of tools for extractive foraging. It has

been suggested that aspects of the species' complex tool behaviour may be socially transmitted, and perhaps even culturally accumulated and refined, but direct evidence for this is still lacking (see Bluff et al., 2010; St Clair et al., 2015).

Many bird species, including migratory birds, use social cues to learn survival-relevant behaviour. Bird song has long been known to be a socially learned phenomenon in passerine species (Nottebohm, 1970). Meanwhile, a range of other bird species learn their migration and homing routes by following others (Mueller et al., 2013; Pettit et al., 2013); a fact that has been suggested to help predict species' resilience to shifting climate (Keith & Bull, 2016). Birds also learn about predators from each other (Griffin, 2004), and they choose breeding and foraging habitat based on the presence of other individuals (Slagsvold & Wiebe, 2011). These tendencies have been used directly in conservation contexts to help teach reintroduced birds about: their native predators (Shier, 2016); their migration route (e.g. the Whooping crane, Urbanek et al., 2010); and to encourage the settlement of restored or unused habitat by broadcasting social cues of conspecific song (Virzi et al., 2012) or erecting conspecific decoy models (Kress & Nettleship, 1988). There is also evidence that human activity can degrade bird social learning channels via noise pollution (Grade & Sieving, 2016).

Reptiles
There is now evidence of social learning in several reptile species, including species of lizards (e.g. Noble et al., 2014) and chelonia (e.g. Wilkinson et al., 2010). While even a non-social tortoise species demonstrates social learning, some more complex social systems allow for a greater number of learning opportunities.

Recent work with the lizard *Pogona vitticeps* (Kis et al., 2015) has demonstrated evidence of imitation in this group. Also, ongoing work (Frohwieser, et al.) is investigating the role of demonstrator knowledge on the use of social information. Environmental change is likely to have substantial impact on ectotherm cognition. Thermal conditions during incubation have been shown to impact learning (Amiel and Shine, 2012) and brain structure (Amiel et al., 2016). Researchers are currently investigating the impact that this has on social learning; early indications suggest that incubation environment impacts on this ability (Siviter et al. in prep), with those incubated in warmer environments being significantly worse at social learning that those incubated at a cooler temperature.

The evidence for social learning within these species indicates that social learning is present across a wide range of taxa. The expert group noted that there are ten species of reptiles listed on the CMS appendices, eight of which are turtles and further investigations into social learning within the Chelonia may be highly beneficial to CMS deliberations.

Fish
Some fish species have been shown to learn socially in contexts ranging from: antipredator behaviour, migration routes and, foraging behaviour, to mate choice (Brown and Laland, 2003). However, social learning about predators has been best studied. Many fish species learn socially about predators via chemically-mediated, conspecific alarm cues. Water-borne pollution can interfere with these learning channels (e.g. Mirza, et al. 2009). The ability of some fish species to learn from the cues of others could also be important in mitigating the effect of invasive predators, although this has yet to be tested in the field.

Mechanisms for social learning
A range of potential mechanisms facilitate social learning. From a conservation perspective, it was agreed that when assessing animal 'cultures', making assumptions about the underlying social learning mechanisms should be avoided, as seemingly complex behaviours may be transmitted through quite 'basic' processes. Nevertheless, understanding the mechanisms behind a specific case of social learning may inform the types of management decisions that will be necessary.

The example discussed was kelp gulls (*Larus dominicanus*), harassing and causing substantive damage to CMS Appendix I-listed southern right whale (*Eubalaena australis*)

mothers and neonates in critical habitat near Peninsula Valdés (Marón et al., 2015). It was noted that in this case culling of the birds may address the immediate problem for the whales, but it was unlikely to be a suitable long-term solution, due to the likelihood of other individuals learning a similar strategy and this behaviour spreading through local enhancement (a form of social learning in which an individual is drawn to a certain location due to the presence of conspecifics).

It was agreed that this case provides an important distinction for management. For example, translocation or culling will not necessarily resolve the problem if the same environmental resources are still available (in this case the whales), as other individuals may simply initiate the same problem behaviour and their presence may, through continued local enhancement, stimulate conspecifics to initiate the same problem behaviour.

This case also highlights the important point that social learning has implications not only for information transmission within and between social groups of the same species, but it can also be highly relevant to conservation issues associated with the interplay between species, also of significance to CMS deliberations. This is most likely to be the case where social learning is associated with foraging strategies, but may also be the case across other behavioural domains.

Another example highlighted was the case of the harbour seals (*Phoca vitulina*) at Children's Pool Beach in La Jolla, California. Hauling out on public beaches is highly atypical for harbour seals. However, over the course of a four-year period, the number of harbour seals hauled out at this site escalated from zero to over 200 by 2009. It is thought that local enhancement may have played a role in this increased use of this public beach by the seals. The positive photo-identification of one seal confirming its presence at both the Children's Pool beach and the Mexican Islas Coronados, indicates that this may be a trans-boundary land-use controversy, resulting from social learning.

2.2 Social role

Evidence for individual social roles has been identified in bottlenose dolphins (*Tursiops sp*) (Lusseau, 2006). It was also noted that in African elephants (*Loxodonta africana*) and killer whales (*Orcinus orca*), there is good evidence for older leaders of social groups playing a central co-ordinating role (McComb et al., 2001, 2011; Williams and Lusseau, 2006). Since matriarchs may act as repositories of social knowledge in some species, social groups may be strongly affected by the removal of just a few key individuals.

A post-reproductive phase in female short-finned pilot whales (*Globicephala macrorhynchus*) and killer whales - an extremely rare developmental stage among mammals - indicates that these older females have an important role (Johnstone and Cant, 2010). This is supported by evidence that post-reproductive female killer whales boost the fitness of kin (Brent et al., 2015).

During the 2014 workshop, participants noted that the removal of individuals from a population could represent more than just a numeric loss to a social group. If, for example, the individual removed was an important repository of cultural knowledge, the long-term success and survival of the whole group might be jeopardised. This was again borne out in the examples discussed by the expert group.

From a CMS perspective two key areas for consideration for the roles of individuals are:
 a) migration to critical habitat through maternally led site-fidelity (as evidenced in some baleen whale species) (Carroll et al., 2014); and
 b) the potential impacts on group survival rates and fecundity from the removal of key individuals (for example, the removal of matriarchs from elephant social units).

Therefore, it was agreed by the expert group that, for some species, protecting individuals who may act as repositories of social knowledge for their social group may be as important as protecting critical habitat. The loss or removal of such 'key' individuals has a far more profound effect on the group or community from which they are removed than simply the subtraction of

a single unit of biomass.

One practical challenge will be identifying key individuals, particularly since this may vary considerably between species. For example, some species copy a particular individual, while others copy all individuals of a certain age/sex/dominance class. Therefore, efforts to identify key individuals must be based on taxa-specific evidence.

2.3 Social structure, social information and culture

Noting that social learning and social structure may have important implications for conservation, evidence from sperm whales (*Physeter macrocephalus*) demonstrates that there is also complex interplay between social structure and the transmission of social knowledge (Cantor et al., 2015; Cantor and Whitehead, 2013). In addition, culture can also increase differentiation and isolation between groups, potentially increasing the speed of genetic drift and differentiation. See, for example, a description of gene-culture co-evolution in killer whales (Foote et al., 2016) and research on southern right whales which suggests maternally-mediated fidelity influences genetic structure across a migratory network (Carroll et al., 2015). These examples demonstrate how culture can be directly linked to units to conserve for migratory species.

Participants of the 2014 workshop noted that poorly-known species may have unsuspected cultural variation in behaviour, and some poorly-known populations of species that are known to show significant cultural variation in behaviours may have behavioural variants that are significant for the viability of that population.

Social learning has the potential to influence how a social group responds to anthropogenic and ecological pressure, both positively (see theoretical models by van der Post and Hogeweg, 2009) and negatively (e.g. social learning of depredation in sperm whales, Schakner et al., 2014), crop raiding behaviours by African elephants (Chiyo et al., 2012) and baboons (Strum, 2010), and reliance on anthropogenic food sources in bears and dolphins (Mazur and Seher, 2008; Donaldson et al., 2012a & 2012b)). Therefore, culture may be an important factor determining whether conservation measures will be effective. One challenge ahead for CMS deliberations on culture and social learning in the migratory species under its purview will be identifying those species that may experience negative conservation outcomes as a result of social learning or culture, whilst also recognizing that some cultural traits may buffer against the effects of environmental stochasticity and increase population viability in a changing environment (Keith and Bull, 2016).

3. Implications for conservation

The 2014 workshop participants identified several areas in which culture may have a range of conservation implications for cetaceans, such as: range recovery (Clapham et al., 2008; Carroll et al., 2011; Baker et al., 2013; Carroll et al., 2014), anthropo-dependence (Ansman et al., 2012; Daura-Jorge et al., 2012), vulnerability due to specialization (Whitehead et al., 2004), interaction with climate change (Colbeck et al. 2013), influence on population structure (Deecke et al., 2000; Rendell et al., 2012; Garland et al., 2011), conflict with human activities (Sigler et al., 2008; Allen et al., 2013) and potentially increased ecological resilience (Ansmann et al., 2012). The participants also noted that in some instances it may be difficult to separate anthropogenic influence from maladaptive culture and further noted some cultural behaviours may have no obvious significance for conservation (these issues are summarized in Table 1 of the workshop report) (CMS, 2014).

Subsequently, Resolution 11.23 requested that the expert group develop "a list of key factors that should be taken into consideration for effective conservation". The expert group agreed that from the perspective of conservation, whether social information use results in discernible culture may not be the key issue. Social information use is dynamic and can be responsive, so from a conservation perspective, one key consideration may be how a social group uses social information, rather than necessarily whether this results in stable culture, although resultant cultures may also continue to influence social learning. However, some degree of temporal stability may be important, as more ephemeral cultures, such as the fads described in some

killer whale populations (Whitehead, 2010) and bottlenose dolphins (Bossley et al., in prep), may be less important for conservation, unless they develop into ethnic markers, or lead to ecological interactions with longer-term consequences.

The group then developed a list of key factors for consideration regarding effective conservation of migratory species that learn socially. These are summarised in Table 1.

Further context is given by Table 2 extracted from Greggor et al. (2017) which categorises conservation issues arising as a result of social learning, in relation to broader conservation aims (quantifying biodiversity, understanding or mitigating threats) and provides examples.

Table 1 Factors to consider for effective conservation of migratory species that learn socially

Factor	Associated questions
Social learning	What evidence is there for social learning of a trait relevant to conservation within the species? Describe the behavioural trait, the transmission mechanism and the conservation implications. Does the behaviour qualify as culture under the agreed definition? Are there learning biases of relevance (see also 'Social Role')?
Behavioural domain	In which behavioural domain does the behaviour reside and how is this relevant to conservation efforts?
Social structure	What is known about the social structure of the population under review?
Social role	Is there evidence for specific social roles which may have relevance to conservation efforts (e.g. individuals that act as repositories of social knowledge)? Is individual identification necessary to make management decisions relevant to the behavioural trait (e.g. identifying matriarchs in elephant groups)? Since some species copy a particular individual, while others copy all individuals of a certain age/sex/dominance class, are there taxa-based rules that can be applied to help identify key individuals? What evidence is there for learning biases that may influence the propensity of others to copy a demonstrator?
Ontogeny	What role does development play in the social learning of this trait? For example, is there a specific developmental window where social learning of this trait occurs?
Ecology, environment and learning	What ecological and environmental factors may influence the progression of this behaviour through the social group (and potentially through the population)?
Social groups and populations	Is the behaviour present in a single or multiple social groups, or more ubiquitous across the population?
Behavioural traits and isolation between social groups	Does the behavioural trait promote isolation between social groups? This may inform understanding of whether a specific trait would influence connectivity between groups and potentially units to conserve

Migration and life cycles	Are there specific implications for migration and the organism's life cycle for the transmission of this behaviour (either positive or negative)?
Resilience or vulnerability	Is the behaviour likely to increase or decrease resilience to human-induced rapid environmental change? How might this change under different scenarios?
Use of novel analytical techniques	Using observational data from the field, can the analysis be aided by statistical modelling and computer simulations, to help interpret the conservation implications of specific socially learnt behaviour?
Implications of conservation intervention	Does the behavioural trait require specific conservation intervention? What are the practicalities and implications of the potential intervention options?

Table 2   Extracted from Greggor et al. (2017): The use of social learning for each main conservation aim

Conservation aim	(1) Quantify biodiversity	(2) Understand threats to biodiversity		(3) Mitigate threats to biodiversity	
Social learning application	Catalogue socially-learned behavioural variants that impact survival	Determine where social transmission is at risk	Predict where animals will be flexible in avoiding threats or adjusting to change	Prevent maladaptive behaviour	Encourage uptake of novel behaviour
Example use	Measure orca group-specific behaviours[1]	Forecast interference in fish chemical communication[2]	Model whether avian migration routes respond to climate change[3]	Stop information spreading about the non-threatening nature of deterrents	Enhance predator avoidance training before release into wild[4]

[1](Ford and Ellis 2006); [2](Mirza et al. 2009); [3](Keith and Bull 2016); [4](Griffin 2004)

Policy implications of social learning in killer whales: a historic case study
During the 2014 workshop the participants discussed the case of Southern Resident killer whales (*Orcinus orca*). Renowned killer whale scientist, John K.B. Ford of Fisheries and Oceans Canada gave a presentation entitled 'Killer Whale Ecotypes in British Columbia: the Role Culture has Played in Identification, Definition and Protection' (CMS 2014). The abstract is reproduced here:

Abstract
Killer whales are high trophic-level social predators that have a cosmopolitan distribution in the world's oceans. Only a single species, *Orcinus orca*, is currently recognized globally but there are multiple genetically and socially discrete regional populations that differ in morphology and ecology and often co-occur in sympatry. Some of these distinct ecotypes have been suggested to warrant status as separate species. The ecological specialisations and related foraging

tactics within killer whale populations appear to be learned behavioural traditions that are passed across generations by cultural transmission. The same is true of various other aspects of their behaviour, such as population- or group-specific vocal patterns. Life history parameters and social structure of killer whales facilitate the development and maintenance of multi-generation cultural traditions. Killer whales are slow to mature, long lived and remain with close matrilineal kin for extended periods, sometimes for life. Some of the best known killer whale ecotypes are found in coastal waters of British Columbia, where on-going annual field studies have been conducted for over four decades. Three sympatric but socially-isolated ecotypes occur sympatrically in the region – Residents, which specialize on salmon prey, Transients (or Bigg's), which specialize on marine mammals, and Offshores, which appear to specialize on sharks. The Resident ecotype is further divided into two distinct subpopulations, the Northern and Southern Residents, which have overlapping ranges but also maintain social isolation from each other. All four of these discrete populations are considered to be separate Designatable Units (DUs) in Canada for conservation and management purposes based on genetic (mtDNA) and cultural distinctiveness. Each is listed as either Endangered or Threatened under Canada's Species At Risk Act and recovery strategies have been developed that explicitly recognize the importance of maintaining cultural identity and continuity of these DUs.

The case of the Southern Residents is unique from a policy perspective, in that this population is listed in both Canadian and the USA's domestic legislation on the basis of social learning. Canada's Committee on the Status of Endangered Wildlife in Canada (COSEWIC) reviewed the data on social learning and discernible cultural in the Southern Resident population, which resulted in the population being listing under the Species at Risk Act as endangered in 2001. The experts determined that the Southern Residents are a separate 'Designatable Unit', on the basis that they are "acoustically, genetically and culturally distinct". This population was also listed under the US Government's Endangered Species Act as a "Distinct Population Segment" in 2004 and listed as Endangered in 2005. Again, the basis for this listing was "differences in cultural traditions, and the Southern Residents may have unique knowledge of the timing and location of salmon runs".

The expert group agreed that, where there is sufficient compelling evidence for conservation significance of social learning, similar provisions in both domestic legislation and through multi-lateral environmental agreements such as CMS, should be explored for a range of taxa.

4.Implications for CMS

CMS is mandated to consider movement across international boundaries for the full extent of a species range (rather than biological migration per se). Social learning is important for some biological migration, but may also be relevant to movement across range state jurisdiction in terms of the location of resources and critical habitat. For example, for those populations that learn socially and straddle boundaries between range states, such as gorillas, their conservation management may be more likely to require international cooperation. Beyond migration, other variation in life history strategies that incorporate the transmission of social information should also be considered within the context of the jurisdictional boundaries that they traverse.

During the April 2014 workshop, the Chair of the CMS Scientific Council noted that "countries had made commitments to preserve biodiversity, which included phenotypic variation which could be due to genetic, environmental and cultural factors". He further noted that "No matter what the cause of the phenotypic diversity, the goal of preserving this variety stayed the same".

Resolution 11.23 also requested the expert group to "develop a list of priority species listed on CMS for comprehensive investigation".

It was agreed that one of the key challenges for conservation managers in bringing evidence in this field into an applied realm will be discerning precisely how the emerging evidence is amenable to management intervention. The challenge arises because each individual case of cultural transmission has unique elements. It was therefore acknowledged that there is some difficulty associated with producing generalised guidance or recommendations on these

issues. It was agreed instead by the expert group that the best way to proceed was to develop some case studies of relevance to CMS. The group developed two case studies for CMS-listed species for which there is strong evidence of social learning having an important role in their conservation: whooping cranes and eastern tropical Pacific sperm whales. These case studies are appended to this report (Appendix II and III).

5.Recommendations

The discussions of the expert group demonstrate that integration of data on social behaviour for the conservation of some species listed on the CMS appendices is profoundly multifaceted. The challenge, amid this complexity, is to tease out the most relevant issues for management purposes.

The expert group acknowledged that some issues raised as potentially important during these discussions may not easily be resolved, as they require deeper technical investigation in an emerging scientific field. However, for the purposes of making some practical recommendations, the group agreed that when assessing populations or social groups, as well as socially-learnt behaviour, other important factors must be taken into consideration. These include social structure and the relevance of social roles to vital rates (Table 1). One way to achieve this is to include social learning as a variable in models that predict species resilience to change (e.g. Keith and Bull, 2016).

This area of work also lends itself to the collection of long-term datasets incorporating focal follow methods, gathering data on individual behaviour. Some emerging methodological approaches which are increasingly used for examining putative cases of culture should also be considered in relation to opportunities for further gathering evidence. For example, in many species, social dynamics (and hence, pathways for the possible social transmission of information) are often very difficult to document in the wild. In recent years, cutting-edge tracking technologies have enabled the mapping of social relationships with unprecedented spatio-temporal resolution (Krause et al. 2013). Nevertheless, for some species long-term data collection in the field on individual behaviour within the context of the physical and social environment may continue to yield important insights.

Emerging knowledge on social structure and the transmission of social information also requires a refinement of standard population models (Brakes and Dall, 2016) which project populations by estimating the number of individuals in each age cohort surviving into the next year and/or reproducing. There is also increasing realisation that the interpretation of observational (field) data can be aided by statistical modelling and computer simulations. Such novel analytical techniques have huge potential and whilst this is an enormous challenge, it is one that CMS may be well placed to spearhead.

The expert group agreed that identifying the examples with the strongest evidence for social learning, which have important implications for the conservation of migratory species should be the focus of future efforts. It is suggested that this can be achieved through the development of CMS relevant case studies, such as those appended to this report. The group also recommends the ongoing monitoring of research in this emerging field.

Summary of key recommendations
- Scientific Council to consider developing a work-plan to take this work forward, using the appended case studies as a basis for identifying and developing further case studies for CMS listed species
- Expert group to continue to identify and explore case studies of relevance to CMS deliberations
- Using the model developed by Whitehead and Rendell at the 2014 workshop, expert group to explore developing a taxonomy of culture across other taxa of relevance to CMS to assist in determining priority species for case studies
- Scientific Council to consider the evidence presented in the two case studies appended to this report and consider recommendations for the COP

- Scientific Council to consider hosting a workshop in 2018 to gather experts from across taxa to focus on a number of key case studies of relevance to CMS conservation efforts and explore the opportunities for engagement across the CMS daughter agreements
- Expert group to explore opportunities to encourage research into social learning in species of key interest to CMS deliberations e.g. chelonia

In closing, the expert group noted how the scientific evidence regarding social learning within the Southern Resident killer whales had been instrumental in shaping policy for this population. The group agreed that, where there is sufficient compelling evidence for conservation significance of social learning, similar provisions in both domestic legislation and through multi-lateral environmental agreements such as CMS, should be explored for a range of taxa, with a focus on, but not limited to, endangered species.

ANNEX 2

DRAFT DECISIONS

NB: Decision 12.AA b) should be read in conjunction with Document 21.1.32.
Proposed new text is <u>underlined</u>. Text to be deleted is ~~crossed out~~.

Directed to the Expert Working Group on Culture and Social Complexity

12.AA   <u>Subject to the availability of resources</u>, the Expert Group is requested to:

a)   <u>develop a workplan to take this work forward, using the case studies appended to the full report contained in UNEP/CMS/COP12/Inf.14 as a basis for identifying and developing further case studies for CMS-listed species;</u>

b)   *~~Requests~~* ~~The expert group, subject to availability of resources,~~ ~~shall~~ <u>to</u> develop a list of priority species listed on <u>the</u> CMS <u>Appendices</u> for a comprehensive investigation of culture and social structure and commence more detailed analysis as appropriate, including for example developing a list of key factors that should be taken into consideration for effective conservation<u>;</u>

c)   <u>using the model developed by Whitehead and Rendell at the 2014 workshop (see UNEP/CMS/COP11/Inf.18), develop a taxonomy of culture across other taxa of relevance to CMS to assist in determining priority species for case studies;</u>

d)   <u>make recommendations to the Scientific Council by the 4th Meeting of the Sessional Committee, based on the evidence presented in the case studies appended to UNEP/CMS/COP12/Inf.14.</u>

Directed to the Secretariat

12.CC   The Secretariat shall:

a)   <u>subject to the availability of resources, convene a workshop to assist the Expert Working Group on Culture and Social Complexity to:</u>
   - <u>develop a list of key factors for identifying priority species and populations listed under CMS where social learning may influence their conservation;</u>
   - <u>identify species or populations in need of Concerted Action;,</u>
   - <u>explore the opportunities for engagement across the CMS daughter agreements.</u>

Directed to the Scientific Council

12.BB   The Scientific Council shall:

b)   <u>consider the outputs of the Expert Group on Culture and Social Complexity and make recommendations to the 13th Meeting of the Conference of the Parties (COP13), based on its findings.</u>