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INTERSESSIONAL REPORT OF THE CMS EXPERT GROUP ON CULTURE AND SOCIAL COMPLEXITY

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

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, as presented in this document.

The related draft resolution and decision are available in UNEP/CMS/COP12/Doc.24.4.3.

INTERSESSIONAL REPORT OF THE CMS EXPERT GROUP ON CULTURE AND SOCIAL COMPLEXITY

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:

<u>Culture:</u>
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.

<u>Social complexity:</u>
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).

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?

<u>Table 2</u> 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)

<u>Policy implications of social learning in killer whales: a historic case study</u>

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 multigeneration 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.

<u>Summary of key recommendations</u>

- 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.

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ANNEX 1

Extracted from Whiten (2000): Some dimensions of social complexity in primates

Dimension	**Scope**
Levels of social structure	Extent to which social environment is structured: a) by interactions constituting relationships; b) by relationships constituting political networks, or differentiated into consistent roles (see text).
Dyadic complexity	Greater complexity where an individual’s interactions with others are more common (e.g. higher rate of interaction, or more interactions); similarly, where more relationships are the rule (as in analyses based on clique size: see Dunbar 1998). Further dyadic-level complexities include reciprocity (in grooming, for example) and exchange (where one type of benefit is traded for another). There is evidence for both these types of complexity in primates (Cords 1997).
Polyadic complexity	Complexities of interaction involving three or more parties, as recognized by Kummer (1967) and now well documented amongst primates (Harcourt & de Waal 1992, Cords 1997). Triadic complexity can also exist at the relationship level (de Waal 1982).
Variability of response	A social initiative may receive very variable responses, even from the same individual on different occasions, in part because of dependence on allies’ availability.
Instability	Relationships vary in stability, creating a pressure to track their status.
Complexity of prediction	The above factors make prediction of the social behaviour of others complex to predict. One measure of this might be the number of factors needed to predict to a certain level of probability. For example, where such factors as rank and availability of allies needs to be considered in addition to rank of protagonist, there is greater social complexity.
Demographic complexity	Although group size in itself may not imply great complexity, it may do so in concert with components like those sketched above. Such factors as turnover (e.g. rate of immigration and emigrations, and possibly group fission) may also be considered background demographic components of the social complexity that the Ego may be faced with.

ANNEX 2

Mitigating losses of animal culture: Case study on re-creating whooping crane migration paths

A. Target species/population(s), and their status in CMS Appendices

While this case study focuses on one species in particular, the whooping crane, examples are also provided where the principles of this mitigation strategy could be applied to other species.

The American whooping crane (*Grus americana*) is an endangered species native to North America (listed on CMS Appendix II; CMS 2015). In the 1940's, only 15 migratory and 7 non-migratory individuals remained of the species. Captive propagation began in the 1960s and reintroductions took place in the 1970s and '80's. These early reintroduction attempts were ineffective due to a lack of survival and pair bond formation (Ellis et al. 1992). It is now understood that one barrier that captive-reared individuals faced was learning their historical migration paths, which previously would have been passed socially from parent to offspring (Mueller et al. 2013).

B. Activities and outcomes of this case study

As part of a larger reintroduction effort that took place between 2001 and 2005 by the Whooping Crane Eastern Partnership, 71 whooping cranes were led along their first migration with ultralight aircraft, after being trained to follow caretakers wearing costumes intended to resemble cranes (Urbanek et al. 2010). From hatching, captive-reared birds were encouraged to imprint on the same costume type, allowing multiple people to act as caretakers. Birds were then trained to follow ultralight aircraft, piloted by a costumed person, and were led from Necedah National Wildlife Refuge (NWR), Central Wisconsin, to their wintering grounds at Chassahowitzka NWR on the Central Gulf Coast of Florida (Urbanek et al. 2005a). In guiding the birds' first migration, the costumed caretakers acted as transmitters of social information, as the parents of cranes historically would.

In conjunction with other management techniques, such as providing artificial roost sites, the outcome of these efforts proved very successful. By the following summer after release 79 per cent of individuals had survived and returned to the release site. Since all birds were tracked and identified, these success figures represent actual survival rates, not just survival estimates (Urbanek et al. 2010).

These methods were first trialed and perfected with the sandhill crane (*Grus canadensis*) (Duff et al. 2001; Urbanek et al. 2005b)—a closely related species with a similar migration route (Toepfer & Crete 1979)—and with the Canada goose (*Branta canadensis*) (Lishman et al. 1997), a species with a strong imprinting tendency and socially learned migration route. Since these strategies were first developed on other species before being used for whooping cranes, it is likely that similar strategies could produce favourable outcomes for other species that share two distinctive traits: a precocial life-history that leads to imprinting on the mother, and a socially learned migration route.

C. Timeframe

Releases that used guided migrations as a strategy occurred for four consecutive years (2001-2005). Within each of those years, individuals were tracked during their spring and fall migration. These releases succeeded in reestablishing an independently migrating and breeding population. As of 2013, the eastern migratory population was made up entirely of released individuals which improved their migration efficiency over consecutive years (Mueller et al. 2013). The species, however, is still endangered, and therefore conservation efforts are ongoing.

D. The case for action

(i) Conservation priority

Once one of the world's rarest species with only 15 migrating individuals, whooping crane populations have grown, but are still listed as endangered by the IUCN. In their case, not only was breeding mitigation necessary for their recovery, but cultural mitigation proved essential beyond regular captive breeding and reintroduction efforts.

(ii) Relevance

Resolution 11.23 on Conservation Implications of Cetacean Culture adopted at COP11 (UNEP/CMS/COP11/Resolution 11.23) noted the findings of the 2014 workshop that "management decisions should be precautionary and assume that populations may contain discrete social elements which have conservation significance warranting further investigation". Further the resolution noted *inter alia* that:

2. highly social species face unique conservation challenges;

3. that the social transmission of knowledge between individuals may increase population viability and provide opportunities for the rapid spread of innovations and thus adaptation to environmental change;

4. whereas this transmission of knowledge may also increase the impact of anthropogenic threats or can operate synergistically with anthropogenic threats to compound their impact on a specific social group or more widely;

5. recognized that the impact of removal of individuals from populations of socially complex species may have consequences beyond simply a reduction in absolute numbers;

6. and that populations of some species are better delineated by cultural behaviour than genetic diversity or geographic isolation;

The Resolution then:

5. encouraged Parties to consider culturally transmitted behaviours when determining conservation measures;

6. urged Parties to apply a precautionary approach to the management of populations for which there is evidence that influence of culture and social complexity may be a conservation issue.

This case study has been developed to highlight the need to consider other CMS species for which similar mitigation strategies may be effective. Migration routes are learned socially across many migrating species, including baleen whales and birds, but appear to be especially important for those that travel in groups (Chernetsov et al. 2004; Palacín et al. 2011; Mueller et al. 2013). Without social learning, naïve cranes are unlikely to migrate successfully on their own the first time (Mueller et al. 2013). For an endangered migratory species, such as the whooping crane, intensive management strategies are needed to evaluate social learning of migration routes. If social learning is important to a migratory species, and there are insufficient demonstrators in the wild from which to learn migratory routes, managers risk losing a substantial proportion of the juveniles they release. Not only does guiding a first migration immediately help released individuals, it also enables the establishment of a migration route for the benefit of future generations.

(iii) Absence of better remedies

This was an innovative conservation science project and at present there is no known alternative for helping birds establish a migration route anew.

(iv) Readiness and feasibility

Before being used on whooping cranes, the methods were first developed with other species (Lishman et al. 1997; Duff et al. 2001; Urbanek et al. 2005b). Some of the science behind the efforts was well established, while other techniques were still relatively new at the time. For example, fostering imprinting was straightforward, since the imprinting tendencies of many species have been studied for decades (e.g. Immelmann 1975). A clever use of costumes exploited this tendency to the benefit of the project. Meanwhile having the birds migrate by following an aircraft was a more challenging aspect of the project, given the potential logistical difficulties of landing in adequate stopovers, and of flying the aircraft itself, etc. Finally, although it has long been thought that birds learn their migration route on their first trip, the science underlying this claim was not fully developed until after the reintroductions took place. There is now, however, strong evidence demonstrating that whooping cranes and other species, such as great bustards (*Otis tarda*) use social experience on their first trip to help guide future migrations and homing routes, and that they can improve their route efficiency over time (Palacín et al. 2011; Mueller et al. 2013; Pettit et al. 2013).

(v) Likelihood of success
The whooping crane case has been widely cited as a conservation success story. Overall, 79 per cent of individuals survived their first winter and successfully migrated back to the release site on their own (Urbanek et al. 2010); a higher percentage than the previous introductions of this species in the 1970's and 80's, which failed. Additionally, data from the whooping cranes has supported greater investigation into the mechanisms of migration in general (Mueller et al. 2013).

Despite its success, very few examples of this type of mitigation have been undertaken on other species, potentially due to difficulties with funding and navigating air space. The fact that a migration route for whooping cranes could be established across the length of the same country made it a more feasible mitigation strategy. In contrast, for species such as the Siberian crane that cross international borders in their migration route (Kanai et al. 2002), piloting ultralight aircraft would involve more concerted and collaborative effort between Range States, something which CMS is well placed to facilitate.

(vi) Magnitude of likely impact
The strategy of guiding whooping crane migration is considered to be an integral part of the success of the reintroduction program (Urbanek et al. 2010). Additionally, as a widely cited example where human intervention helped re-create cultural processes, the whooping crane case has sparked increased interest in conserving animal culture because of its relevance to survival (Keith & Bull 2016; van Dooren 2016), and its relevance for using animal learning and behaviour as a conservation tool (Sutherland 1998; Greggor et al. 2014; Proppe et al. 2016). This type of strategy has the potential to provide flagship collaborations between Range States, integrating the science on social learning into practical conservation for migratory species.

(vii) Cost-effectiveness
Reintroductions tend to be a last resort as a mitigation strategy, used only when other approaches fail. Captive rearing and reintroductions are generally costly, and therefore often involve multiple partners and funding bodies. The whooping crane example is no exception. However, the considerable costs that would have been incurred for captive breeding and release would have been wasted without the added expense of ultralight aircraft. This resulted in an outcome an order of magnitude more successful than previous release efforts, which is anticipated will yield benefits for many subsequent generations of whooping cranes. This case provides an important example of how utilizing emerging understanding of social learning can provide strategies and techniques for more cost-effective conservation in the long term.

E. Associated benefits

Apart from helping establish a migrating and breeding population of whooping cranes, this case study has also had great impact on the field of animal culture and conservation behaviour (see section vi). Additionally, as a conservation success story with a novel technique, it has garnered much public attention and support, as seen through the comprehensive coverage of it from outlets ranging from the New York Times to National Geographic. Helping animals maintain their culture appears to be an issue that can be used to raise awareness of conservation efforts in general.

F. Relationship to other CMS actions

As a successful case study, the whooping crane example offers insight into how cultural migration can be recreated, especially for imprinting species.

Resolution 11.23 on Conservation Implications of Cetacean Culture adopted at COP11 (UNEP/CMS/COP11/Resolution 11.23) noted the findings of the 2014 workshop that "management decisions should be precautionary and assume that populations may contain discrete social elements which have conservation significance warranting further investigation".

The resolution further recognized that "the impact of removal of individuals from populations of socially complex species may have consequences beyond simply a reduction in absolute numbers" and this may particularly be the case where knowledge of migratory routes is lost, since such loss of knowledge may impede recovery.

The whooping crane case study provides an important example of how innovative research and collaboration between Range States could be used to address complex conservation problems associated with the management of animals that learn socially.

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ANNEX 3

Proposal to undertake Concerted Actions for Eastern Tropical Pacific Sperm Whales (*Physeter macrocephalus*) within the existing global concerted action for the species

A. Target species/population(s), and their status in CMS Appendices

Sperm Whales (*Physeter macrocephalus*) are a highly migratory marine species, listed on Appendix I and II of CMS (CMS, 2015), which have been included on the CMS concerted action species list since 2002. They are listed globally as vulnerable on the IUCN Red-List[1], with the Mediterranean sub-population categorized as endangered[2].

This proposal for concerted action is focused specifically on four clans of Sperm Whales which have been identified in the eastern tropical Pacific (etP) (Rendell and Whitehead, 2003; Cantor *et al*. 2016). Decades of research has revealed a complex social structure within the etP Sperm Whales, where clans can be identified by their unique acoustic click patterns or codas, but also differ in their movement patterns, feeding success and other attributes (e.g. Whitehead & Rendell, 2004). The clans in this region are known as the Regular, Plus-one, Short and Four-plus clans.

These large clan structures are often sympatric, with two or three clans using a given area. The geographic distributions of the clans are also dynamic so that the clans using a sea area can change over years or decades (Cantor *et al*. 2016), representing large-scale population shifts that are not readily detectable from basic sighting surveys which record only the presence of whales without respect to clan membership. However, these clans show little or no differences in their nuclear DNA and the primary differences between them are socially learned and therefore, cultural (Whitehead, 2003).

Since social learning is understood to be the major driver for the clan structure within this species and there is important interplay between social structure and the transmission of social learning within these social systems (Whitehead and Lusseau, 2012), the clan structure presents unique conservation challenges. For example, there is compelling evidence for differential responses between clans to environmental variability (either natural or anthropogenic), which may have important management implications for sperm whale cultural units in this region (see section D).

CMS Range States in which individuals from different etP Sperm Whale clans have been identified

Clan	**Panama**	**Ecuador**	**Peru**	**Chile**
Regular		**X**	**X**	**X**
Plus-one	**X**	**X**		
Short	**X**	**X, Y**	**X**	**X**
Four-plus		**Y**	**X**	**X**

Data from: **X** Rendell, L. & Whitehead, H. (2003). **Y** Cantor, M. *et al*. (2016)

1 http://www.iucnredlist.org/details/41755/0 (last assessed 2008)
2 http://www.iucnredlist.org/details/16370739/0 (last assessed 2012)

Movements of photo-identified individuals between CMS Range States

	Panama	Ecuador	Peru	Chile
Panama				
Ecuador	8			
Peru		2		
Chile		8	1	

[Assuming maritime boundary between Ecuador and Peru at 3.39ºS, between Chile and Peru at 18.35ºS]
Data from**:** (reanalysis based upon maritime boundaries given above): Whitehead, H., A. Coakes, N. Jaquet and S. Lusseau. (2008).

Movements of individuals of known clan between CMS Range States

	Panama	Ecuador	Peru	Chile
Panama				
Ecuador	8 *Plus-one*			
Peru		2 *Short*		
Chile		1 *Regular*; 5 *Short*	1 *Regular*	

Data from: H. Whitehead (unpublished)

B. Activities and expected outcomes

Institutional Activities:
It is proposed that as a specific action for the eastern tropical Pacific region, under the existing concerted action for Sperm Whales, a concerted action is undertaken for etP Sperm Whales, based on their culture, with the objective of creating a collaboration across Range States for data gathering within their jurisdictional waters (and where possible, beyond). The key elements of this collaboration would be to enable photo identification, acoustic monitoring and where possible, the collection of behavioural data and faecal samples to further elucidate social structure and differences in foraging success between clans. Passive acoustic monitoring will be particularly useful as the presence, and clan membership, of Sperm Whales can now be detected autonomously over large spatial and temporal scales (Rendell & Whitehead 2004; Zimmer 2011). Additional ecological data including environmental monitoring and prey distribution would also be highly valuable. The scientific leader of this collaboration (Dr Luke Rendell) would then report back to the next CMS Conference of the Parties in 2020.

The strategic objectives of this collaboration would be to obtain more detailed information about the social structure, foraging behaviour and acoustic segregation of Sperm Whales in the eastern tropical Pacific to determine whether and how these clans should be conserved separately according to their differing responses to environmental pressures. For example, continuing research in the region on foraging success during differing environmental conditions could be used to project the expected relative population growth rates of clans that differ in feeding strategies.

The main role of CMS Parties would be to facilitate, where possible and appropriate, collaboration between institutes and researchers.

Outcomes:
Encourage capacity-building and collaboration between academic institutions and Range States, using integrated research methods. This is particularly important research because it will provide insights into how we manage these (and other) long-lived, highly social animals. For example, providing insights on whether acoustic clans of Sperm Whales should be managed separately (as socially significant units). This approach contrasts with geographic definitions of stock structure, which can fail to capture the dynamics of the sympathetic clans.

Determine whether more targeted concerted actions are necessary for these cultural units of whales, in order to provide more focused attention on the necessary conservation measures. This will ensure that conservation policy is consistent with the most up-to-date scientific knowledge on how populations of these difficult to study species are organized and may respond to anthropogenic threats and conservation actions.

C. Timeframe

Milestones

- Agreement at the 2017 COP that the etP Sperm Whale clans should go into the concerted action process on the basis of socially learnt behaviour, which segregates them and may require them to be managed as distinct population segments
- Project leader to discuss preliminary collaboration between relevant institutes (by 20 December 2017)
- Funding requirements determined and resources secured (by 30 October 2018)
- Project leader to facilitate data collection as per standardized data collection protocol (by June 2019)
- Preliminary result analyzed and reported back to the Scientific Council and the CMS COP in 2020 by the project leader
- Next steps in relation to conservation of etP Sperm Whale conservation agreed (2020)

D. The case for action

(i) Conservation priority
In 2014 the CMS and WDC jointly hosted a workshop on the conservation implications of cetacean culture at the Linnaean Society in London (CMS, 2014). The workshop culminated in the adoption of Resolution 11.23 on Conservation Implications of Cetacean Culture adopted at COP11 (UNEP/CMS/COP11/Resolution 11.23). The Resolution 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 deliberations of this expert group are described in the report ‘CMS Expert Working Group on Culture Intersessional Report’ to which this case study is appended.

The expert group discussed several instances where social knowledge may result in vulnerability or resilience to anthropogenic change. In order to distil some practical management advice on this burgeoning area of conservation science, it was agreed that case studies could provide the best insights, since each instance of social learning and interaction with the environment may be unique.

To that end etP Sperm Whales were considered to be a suitable case study, as there is good evidence for social learning relevant to their conservation across several behavioural domains.

Socially learnt behavioural (cultural) differences between Sperm Whale clans in the eastern tropical Pacific

Trait	Strength of evidence	Reference
Coda dialect	Excellent	Rendell & Whitehead 2003
Geographical extent	Excellent	Rendell & Whitehead 2003
Small-scale distributions (10’s km)	Good	Whitehead & Rendell 2004
Large-scale movements (days-years)	Good	Whitehead et al. 2008
Small-scale movements (hours)	Good	Whitehead & Rendell 2004
Feeding success	Good	Whitehead & Rendell 2004
Changes in feeding success with El Nino	OK	Whitehead & Rendell 2004
Diet	Indication	Marcoux et al. 2007b
Reproductive rates	OK	Marcoux et al. 2007a
Diving synchrony (babysitting)	OK	Cantor & Whitehead 2015
Homogeneity of social relationships within social units	OK	Cantor & Whitehead 2015
Duration of social relationships	Indication	Cantor & Whitehead 2015

The main prey of Sperm Whales in the etP is mesopelagic squid. Nevertheless, differential feeding success under different oceanographic conditions have been observed in this region. Research on Sperm Whales off the Galápagos Islands has shown that in the 1980s and 1990s there were two clans principally found in this area. Results from studies on defecation rates indicated that in normal years, the regular clan had higher defecation rates, but during a warm El Niño year, when all of the animals showed greatly reduced defecation rates, the plus-one clan consistently had a higher rate than the regular clan (Whitehead, 2010; Marcoux, Rendell, & Whitehead, 2007a). Since the clans were feeding in the same area and in the absence of any signs of aggression, this difference in defecation rate is inferred to be due to different feeding strategies having different benefits during these oceanographic cycles. These two clans also show evidence for differences in reproductive success (Marcoux, Rendell, & Whitehead, 2007b). Subsequent field research has since revealed what scientists are calling a ‘cultural turnover’ in which two other clans appear to have usurped regular and plus-one clans in this area (Cantor *et al*., 2016). The evidence for differential effects arising from changes in environmental conditions coupled with the complex dynamics of the sperm whale clan structure in this region provide a compelling case that these whales should be managed in a modular fashion. Further, it is predicted that as a result of global warming, El Niño frequency and duration is expected to change, so the differential reactions of these clans to the El Niño cycle may be particularly important.

(ii) Relevance

Whitehead (2003) noted that the offshore distribution and habitat use by Sperm Whales is generally not well understood. However, in the last decade an emerging understanding of the complex clan structure of etP Sperm Whales, including cultural turnover between clans in this region (Cantor et al., 2016), has emerged. This is a highly migratory marine species, listed on CMS Appendix I and II and listed globally as vulnerable by the IUCN. It is the view of the culture expert group that the Sperm Whale clans in this oceanographic region provide an excellent example of the challenges associated with managing highly migratory species that learn socially and have complex social structures, which may therefore require multilateral collaboration for monitoring and conservation.

Resolution 11.23 on Conservation Implications of Cetacean Culture adopted at COP11 (UNEP/CMS/COP11/Resolution 11.23) noted the findings of the 2014 workshop that “management decisions should be precautionary and assume that populations may contain discrete social elements which have conservation significance warranting further investigation”. Further the resolution noted *inter alia* that:

- a number of socially complex mammalian species, such as several species of cetaceans, great apes and elephants, show evidence of having non-human culture;
- highly social species face unique conservation challenges;
- that the social transmission of knowledge between individuals may increase population viability and provide opportunities for the rapid spread of innovations and thus adaptation to environmental change;
- whereas this transmission of knowledge may also increase the impact of anthropogenic threats or can operate synergistically with anthropogenic threats to compound their impact on a specific social group or more widely;
- recognized that the impact of removal of individuals from populations of socially complex species may have consequences beyond simply a reduction in absolute numbers;
- and that populations of some species are better delineated by cultural behaviour than genetic diversity or geographic isolation;

The Resolution then:

- encouraged Parties to consider culturally transmitted behaviours when determining conservation measures;
- encouraged Parties and other stakeholders to assess anthropogenic threats to socially complex mammalian species on the basis of evidence of interactions of those threats with social structure and culture; and
- urged Parties to apply a precautionary approach to the management of populations for which there is evidence that influence of culture and social complexity may be a conservation issue.

Finally, of most relevance to this case study, the resolution also encouraged Parties and other stakeholders **to gather and publish pertinent data for advancing the conservation management of these populations and discrete social groups**. This concerted action is targeted specifically at achieving that objective.

(iii) Absence of better remedies
CMS is uniquely positioned as the only multi-lateral environmental agreement currently engaging with the policy implications of this emerging field of science. Moving beyond the traditional approach of conserving only genotypic diversity towards a more advanced approach, which incorporates specific aspects of phenotypic diversity, is likely to provide opportunities for more efficient and effective methods for conserving some species that learn socially.

(iv) Readiness and feasibility
This proposal requires, wherever possible and appropriate, Range States to support and facilitate collaboration between the necessary experts, specifically to increase data collection, initially through passive acoustic monitoring and to investigate other opportunities for collaboration on data gathering for this species. Dr. Luke Rendell of St Andrews University in Scotland, who has extensive experience researching Sperm Whales in this region and has relevant academic contacts in the region, has offered to provide leadership for this project. Professor Hal Whitehead of Dalhousie University, Canada has also offered to provide his expertise and guidance to assist this project.

This is a novel area of conservation science, with the potential to attract funds from external sources.

(v) Likelihood of success
Implementation of this collaboration will facilitate a better understanding of distribution of the clans across the Range States, providing higher resolution data on distribution, clan mixing

and potentially on feeding behaviour. This will provide insights into how changes in the environment, both natural and anthropogenic, may differentially affect these discrete clans and thus how they may need to be managed accordingly. There is a high probability of success through this collaboration because there are already researchers with experience and expertise in this field within the region and both Dr. Rendell and Professor Whitehead have good contacts with many of these researchers.

Capacity-building across the scientific community and collaboration between institutes undertaking research on this species within the region will provide a legacy mechanism, through which ongoing data can be collected to better understand the patterns of change between these cultural units.

(vi) Magnitude of likely impact

This has the potential to be a flagship collaboration for integrating the science on social learning and social structure into practical conservation for migratory species. Therefore, this concerted action has excellent potential as a catalyst for further collaborations, across a wide range of taxa, which can assist the CMS Parties in conserving migratory species that learn socially.

(vii) Cost-effectiveness

Because this concerted action has the potential to become a flagship project and because the research is ongoing and the demands on Parties is not onerous, seeking only that the Range States facilitate and support this initiative wherever possible and appropriate, it likely to be highly cost-effective for CMS, in terms of developing competency as an multi-lateral agreement leading understanding in this aspect of modern conservation efforts.

E. Associated benefits

Public outreach in an emerging field of conservation science, the policy implications of which CMS is spearheading. It is also anticipated that information garnered and lessons learnt through this collaboration may also benefit similar initiatives on other CMS-listed species in the future.

F. Relationship to other CMS actions

CMS Resolution 10.15 Global Programme of Work for Cetaceans (2012-2024) instructed the CMS Scientific Council's Aquatic Mammals Working Group to provide advice on the impact of the emergent science of cetacean social complexity and culture as it related to regional populations.

This instruction resulted in the hosting of the 2014 workshop (CMS, 2014) and the adoption of Resolution 11.23 on Conservation Implications of Cetacean Culture adopted at COP11 (UNEP/CMS/COP11/Resolution 11.23). The ongoing objectives of this Resolution (outlined in section D(ii) above) can only be achieved for highly migratory marine species such as sperm whales, by undertaking the type of collaboration between range states suggested in this concerted action.

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