Open Journal of Leadership, 2014, 3, 53-65
Published Online June 2014 in SciRes. http://www.scirp.org/journal/ojl
http://dx.doi.org/10.4236/ojl.2014.32006

Does Deming's "System of Profound Knowledge" Apply to Leaders of Biodiversity Conservation?

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Received 22 March 2014; revised 25 April 2014; accepted 10 May 2014

Abstract

The challenges of ecological and environmental change are significant and solutions remain largely under the influence of people and the decisions of governments, interest groups, national and local communities and individuals. Evidence suggests that despite 20 years of effort, conservation initiatives have failed to achieve the targets set for protecting biodiversity in the UN Convention on Biological Diversity 2010. A common factor influencing effectiveness of conservation work undertaken by the diverse mix of government, non-government and civil organisations is leadership. A command-and-control approach to leadership is commonly encountered in conservation and previous reviews suggest this as a major factor in ineffective conservation initiatives. This suggests that conservation leaders should consider a fundamentally different approach to leadership. We examine whether an alternative paradigm, Deming's System of Profound Knowledge, offers a suitable new basis for leadership in biodiversity conservation. This "Systems Thinking" approach should encompass (i) an understanding of natural systems, (ii) a sense of how human behaviour is influenced, (iii) an understanding of how knowledge should inform decision-making and problem solving, and (iv) an understanding of variation in natural systems. Current paradigms of conservation management fail to address these four fundamentals and therefore do not represent the most effective way to manage conservation. Conversely, challenges and opportunities encountered in biodiversity conservation are well-aligned to a Systems Thinking approach. Leadership approaches defined in Deming's "System of Profound Knowledge" offer significant positive impacts on biodiversity conservation achievement and provide lessons for leaders in other areas of human activity.

Keywords

Systems Thinking, Leadership, Environmental Management

How to cite this paper: Black, S. A., & Copsey, J. A. (2014). Does Deming's "System of Profound Knowledge" Apply to Leaders of Biodiversity Conservation? *Open Journal of Leadership, 3,* 53-65. http://dx.doi.org/10.4236/ojl.2014.32006

1. Introduction

Ecological change is a significant challenge for human society in terms of ecosystem degradation, declining productivity of marine fisheries, reduced water catchment, degraded soil fertility, losses of carbon capture through deforestation, and accelerated rates of species extinction (Soulé, 1985; Caughley & Gunn, 1996; Rockström et al., 2009). In the face of human population growth and land use changes, the solutions to regulate and mitigate these pressures largely lie with human society rather than a reliance on the innate robustness of natural systems (Holling & Meffe, 1996). The solutions to these types of challenge reside in the collective intelligence of the people doing the work (Heifetz & Laurie, 1997) in order to solve the problems of biodiversity loss. The enabling of conservation organizations to engage with this challenge in an effective and impactful manner is essentially the job of leadership. The recent decisions of large conservation NGOs and government organizations such as the US Fish and Wildlife Service to examine commitments, strategies and leadership approach in response to the pressures on species and landscapes (USFWS, 2010; CLP, 2014) is a reflection of the renewed interest in leadership as a major influencing factor. The renewed focus in the wildlife sector relates issues common to many other sectors: managing complexity, uncertainty, unintended impacts of interventions, goal displacement, and how to link task management ("the work") with "people management".

The current dominant management perspective in the biodiversity conservation sector is "command-and-control" (Clark, Reading, & Clarke, 1994; Holling & Meffe, 1996; Black, Groombridge, & Jones, 2011), which is unsurprising since this mind-set remains the "default" in many industrial, commercial and public sectors (Deming, 1982; Joiner, 1994; Basset-Jones & Lloyd, 2005; Seddon, 2003; Jacobs, 2009). Command-and-control is a product of the empirical-rational approach to management and education which has dominated Western thinking for decades (Chin & Benne, 1985; Kohn, 1986). Command-and-control is characterized by top-down hierarchies, functional specialism, decisions made by managers, measurement by output, and a focus on people and budgets (Macdonald, 1998; Seddon, 2003).

Limitations of command-and-control leadership are noted in management literature (Deming, 1982; Scholtes, 1998; Seddon, 2003; Jacobs, 2009). Fundamental problems and negative outcomes have also been shown to arise when applying command-and-control thinking in wildlife conservation (Clark et al., 1994; Holling & Meffe, 1996; Black et al., 2011; Martin et al., 2012). For example, command-and-control assumes that any problem is well-bounded, clearly defined, relatively simple and generally linear in terms of cause and effect, all assumptions which fail to match the complex, nonlinear and poorly understood natural world (Holling & Meffe, 1996; Sterling, Gomez, & Porzecanski, 2010). Conservation practitioners need to engage with a better approach to handle the complexity of leading people within their organization, influencing wider human society and aiding the natural world (Black, Meredith, & Groombridge, 2011).

We argue for a new paradigm in conservation leadership based on recognition that biological systems and the human systems with which they interact are complex and poorly-understood. Conservation leaders need the ability to filter speculation from sound knowledge and be willing to make decisions based on limited information. We suggest that Deming's (1994) "System of Profound Knowledge" is a valuable guide for developing leadership thinking within the conservation profession. Rather than focusing on the development of quantitative targets and "best practice" we argue for an approach that recognizes uncertainty as a fact of conservation life and therefore requires leaders to examine how to manage with varying levels of knowledge. Leaders need to appreciate that influencing people is the route to successful biodiversity recovery, and that embracing new ways to understand systems and variation will enable more effective leadership to improve the status of biodiversity on the planet.

2. Managing Change in Biological Systems

Life on Earth is complex: individuals, communities, species, habitats and ecosystems are constantly in flux, shaping or being shaped by a multitude of forces (Bertalanffy, 1969). The acquisition of knowledge to understand these complex biological systems is a significant undertaking. Knowledge gaps still remain concerning the impacts of climate change, how ecosystems function, the relative importance of ecosystem services, the consequences of ecological degradation, how best to manage protected areas, how to restore degraded habitats, and how to use technology to assist conservation action (Sutherland, Pullin, Dolman, & Knight, 2004). Additionally, an appreciation of how intervention at any single point in a system can cause unplanned and unintended effects elsewhere, suggests that knowing how to experiment with change is an important competence to acquire (Deming, 1982; Senge, 1990). Although concern for the impact of change is not exclusive to conservation leaders, the effects of poorly applied thinking can be readily illustrated in biological systems.

An interesting example to illustrate these inter-relations is provided by the case of feral cats in Tasmania, where the spread of the cat population has been facilitated by the degradation of the native habitat and subsequent loss (by human extirpation) of certain top native predators. A parasite carried by cats has exacerbated impacts on native species such as the carnivorous marsupial, the Tasmanian Devil (*Sarcophilus harrisii*) which, due to evolution in isolation on Tasmania, is particularly susceptible, elevating the risk of its extinction (Hollings, Jones, Mooney, & McCallum, 2013).

Sometimes human interventions to conserve biodiversity have resulted in unforeseen, negative consequences. Removal of cats to aid biodiversity recovery on the Sub-Antarctic Macquarie Island led to a growth in the population of the introduced rabbits which, free from cat predation, then altered the complex plant communities that existed, through grazing (Bergstrom et al., 2009). Efforts to restore the endangered Galapagos giant tortoise (*Chelonoidis nigra hoodensis*) are now recognized for the potentially negative impact on the status of the native *Opuntia* cacti, through trampling and over-grazing (Gibbs, Sterling, & Zabala, 2010).

Conservation biology is a "*crisis discipline*", one in which individuals must be comfortable to act "*… before knowing all the facts*" (Soulé, 1985: 727). At a practical level managers need the ability to tolerate uncertainty as a prerequisite of the profession, including judgment of how much information is required before action is taken. Moving too fast can mean resources are wasted unnecessarily, whilst acting too slow can lead to the irreplaceable loss of biodiversity. Nevertheless it is still the case that some species have been "studied to extinction", in part as a consequence of managers failing to address the critical questions and then missing timely leadership decisions to intervene until it was too late (Martin et al., 2012).

While our knowledge of biodiversity at the species level is arguably more complete than for other components, we have determined the extinction risk for only approximately 5% of species on the planet (IUCN, 2013). The addition of the human factor to biological systems has added to this complexity. For example, determining the relationship between human culture and livelihoods and biological diversity has demanded a more nuanced understanding of how and where to intervene to maintain natural systems (Xu, Lebel, & Sturgeon, 2009). Conservation managers therefore operate within a system for which there are many more questions than answers. As well as understanding how to separate a sound knowledge-base from speculative "knowledge", conservation leaders must be comfortable with uncertainty.

Conservation programs are by their nature open systems (Wallace, 1994; Wallington, Hobbs, & Moore, 2005). In recent years a systemic view of ecological processes has led to improved insights into the effects of change on ecosystems, such as the impact of elimination of top predators from marine food chains (Sterling, Gómez, & Porzecanski, 2010). Conservation work, be it species recovery, habitat restoration, law enforcement, socio-economic re-structuring or any other aspect should be linked to the natural ecosystems of concern. For example marine conservation protected areas must be designed and managed in line with the human communities, geographic location, and species and ecosystems under protection (Caughley & Gunn, 1996). Similarly, conservation of a single species such as the California Condor (*Gymnogyps californianus*) or Florida Manatee (*Trichechus manatus latirostris*) must enable the species to survive in its habitat without threat from human encroachment, pollution or development activity (Clark et al., 1994).

3. Existing Paradigms in Conservation Leadership

In an attempt to modernize biodiversity management thinking, a number of "good management practice" approaches have arisen in the conservation sector in the shape of initiatives such as the World Conservation Union [IUCN] framework for evaluating protected areas (Hockings et al., 2006) and the Conservation Measures Partnership's (2004) open standards for the practice of conservation. Whilst the intention behind these efforts is laudable, the "standards" approach (essentially steering managers towards "best practice" behaviors) has been questioned in general management circles for the constraints it places upon creativity and problem-solving, and the unhelpful bureaucracies which tend to emerge (MacDonald, 1998; Seddon, 2003; Manolis, 2009). Standards frameworks do not address either the behavioral nor technical aspects of leadership so are unlikely to achieve the best long-term results (Mauro, 1999). Management standards tend to encourage leaders to build an "arsenal" of supposed effective behavior, rather than understanding the work, which itself would better steer more meaningful leadership behavior. In short, management standards should not be considered as a source of "good practice" (Black, Groombridge, & Jones, 2013).

Furthermore a now common practice in the conservation sector is for managers to follow the "Logical Framework Approach" (Coleman, 1987) to identify project actions and output indicators which typically take the form of activity measures and project milestones. The use of log frames is promoted in conservation funding circles, despite criticism of the methodology in terms of its limitations (Hummelbrunner, 2010). The difficulty with the Logical Framework methodology is that program logic does not explore the depth of interrelationships which affect the success of program work (Rogers & Williams, 2010). By over-simplifying cause and effect within the system these approaches can focus program managers on inappropriate measures and indicators of success. A simple example of this error would be where a program is focused on a limited scientific perspective when, in practice, community involvement might be the best point of intervention to address the conservation threats which are being encountered. Conservation leaders should be encouraged to seek other ways to examine how to make interventions more effective for the benefit of the species and ecosystems.

4. An Alternative Perspective on Leadership in Conservation

Deming (1994) suggests four areas of leadership competence, in his System of Profound Knowledge, where each works in harmony with the others (McNary, 1997):

1) Appreciation for a system;
2) Some knowledge of the theory of variation;
3) A theory of knowledge;
4) Some knowledge of psychology (Deming, 1982; Scholtes, 1998; Mauro, 1999).

In biodiversity management leaders generally have a dual role of managing both behavioral leadership (people and organizations) and technical leadership (scientific and technical solutions relating to the problems of biodiversity conservation). This situation can be readily recognized in other technical sectors, such as engineering or healthcare. The Deming philosophy offers a theory base to address both people and technical management (Mauro, 1999), so could be applied by leaders of biodiversity conservation, much as it relates to other sectors.

4.1. Would an Understanding of Ecosystems and Human Created Systems Be Helpful?

Deming's discussion of systems relate largely to industrial, manufacturing, commercial public, educational and service organizations, but he made a fleeting, if somewhat mischievous, wildlife reference to illustrate the complexity of systems in his regular seminars "*We know how to optimize pieces*, *but optimization of a larger system is difficult. A system must be managed*… [*Take*] *a tiger. Without an aim in life*, *he is only a tiger. Once he had an aim*, *then there will be a system. The tiger will be an important part of the system*, *but he alone does not make a system. What might be his aim*? *Here are some possibilities*…1. *to become a great hearth rug*; 2. *to stabilize the number of deer in the forest*; 3. *to stabilize the number of people in the village*." (Kilian, 1992: 258). Clearly the purpose of the system has a significant impact upon the way it is managed.

Since conservation work involves open systems (Wallace, 1994; Wallington et al., 2005), this suggests that conservation leaders should consider the interaction of all elements in their programs: species, ecosystems, landscapes, human communities, teams, work, resources, goals, and plans from a systems perspective (Bertalanffy, 1969; Black et al., 2013). According to Deming (1986) two key principles relate to these types of complexes; (i) there are many processes where people can and do affect the outcomes; (ii) chaos can occur when those people use inappropriate methods to try to influence outcomes. The second of these principles relate to an understanding of natural variation. Aligned to these principles is the observation that systems rarely behave in a simple cause-effect relationship (Sherkenbach, 1991), and in practice this is frequently encountered with ecological change (Sterling et al., 2010).

Although by prior training, conservation scientists can often have an awareness of ecological systems, there remains a critical need for conservation leaders to learn how human organizations operate as part of the system; namely the conservation program itself, the teams involved, and local and wider communities (Black et al., 2011; Clark et al., 1994). Although a conservation managers' job is to understand species and ecosystems and to take action on causes of threat or decline (Black & Groombridge, 2010), they also need, in practice, to establish a clear purpose, devise measures of performance, organize the work, make decisions, solve problems and continually revisit priorities. The most successful programs retain a legacy of hands-on conservation work after initial recovery effort has been achieved (Goble, Wiens, Scott, Male, & Hall, 2012; Black et al., 2013). So the ability of leaders to design and establish on-going philosophies and working principles will have a long-term influence on the continued viability of conserved populations, species and habitats.

Unfortunately, the established mindset of logframe-influenced thinking has tended to drive managers within the conservation sector increasingly towards an inappropriate focus upon activities and project milestones (Ferraro & Pattanayak, 2006), an approach which was precisely the reasons for misdirection of work away from efforts to save species such as the Black-footed Ferret (*Mustela nigripes*), the Yangtze river dolphin (*Lipotes vexillifer*) and the Po'ouli (*Melamprosops phaeosoma*), a rare Hawaiian forest bird (Clark et al., 1994; Turvey, 2008; Powell, 2008). In those cases teams needed to be led in a way which was responsive to the need of the species and its ecosystem, yet instead became caught in the procedures, funding protocols and deadlines defined by the system of project management. The Black-footed Ferret survived by the narrowest of margins whilst the Po'ouli and Yangtze river dolphin disappeared into extinction in the 21st Century.

4.2. Can Theory of Knowledge Address Scientific Certainty, Imprecision or Data Shortfall?

"Systems Thinking" enables better use of data for problem solving, decision making, goal-setting, planning and action (Seddon, 2003) shifting a leader's mind-set from "what do we **think** is happening" to "what do we **know** is happening". In Deming's system of profound knowledge this requires leaders to better understand what "knowledge" really means, based on a sound theory of knowledge (Russell, 1926; Lewis, 1932). Since conservation leaders commonly have a scientific background, confidence in knowledge (and the ability to make decisions on the basis of knowledge) is critical. Adair (2005: 14) believes confidence to be the single "… *absolutely indispensable qualification*" to become an effective leader. In conservation, knowledge is an indispensable element to support confidence.

However, there are well-documented occasions in conservation management when attempting to acquire additional scientific knowledge has proven counterproductive. The Christmas Island Pipistrelle Bat (*Pipistrellus murrayi*) was monitored in the face of population decline to the point of extinction (Martin et al., 2012), whilst the Po'ouli fell to extinction during a period when it was monitored (for the numbers of these birds in the population) without accumulating any helpful information needed to conserve the species until it was too late (Groombridge et al., 2004). In layman's terms, both projects were victims of paralysis by analysis: inaction due to a fixation on identifying definitive data before decisions can be made (Langley, 1995).

The difficulty concerns how conservation leaders deal with uncertainty. Conservation sciences can, at one extreme, provide rich tapestries of information (e.g. genetics, population data, behavioural data, climate data) whilst conversely, endangered species can be cryptic or inhabit remote areas so many unknowns also apply (Black et al., 2013). Conservation scientists commonly experience the need to handle imprecise data (Martin et al., 2012), whilst also grappling to meet the demands of scientific certainty. In this paradox it is important that conservations leaders are able to make assumptions about the knowledge using a sound theory base (Scholtes, 1998). In some areas knowledge will be precise, whilst in others it will be based on less clear evidence or "belief" (Russell, 1926; Lewis, 1932).

In the case of both the Christmas Island Pipistrelle and the Po'ouli, effort would have been better based upon reasonable assumptions to initially recover the species. This better alternative approach is illustrated in successful recovery of the Mauritius Kestrel (*Falco punctatus)* from a single breeding pair of birds (Jones et al., 1995) and the Orange-bellied Parrot (*Neophema chrysogaster*), where, after initial action based on assumption, subsequent accumulation of new knowledge now informs longer term species recovery (Martin et al., 2012). Conservation science already has its own premise for these situations, the "Precautionary Principle" (Foster, Vecchia, & Repacholi, 2000), where "*lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*" (UN, 1992, principle 15). Practitioners should keep the principle at the forefront of their minds: able to act before full scientific certainty is known. Senge (1990) encourages leaders to ally rational reasoning with intuitive skills; both data and intuition are useful resources. With an understanding of the theory of knowledge, conservation leaders can discern the path between one extreme of a reliance on experience or "gut feeling" to the other extreme of working only on the basis of scientific certainty.

Conservation is a crisis discipline (Soulé, 1985), with a focus on problem-solving and mitigation of threats, often under the pressure of time and imminent demise of the species and ecosystems of concern. Knowledge in this context concerns how conservation practitioners identify and regard data (e.g. population size, reproduction, mortality, threats) and apply analyses to guide work in response to circumstances and need. Fundamentally in biodiversity conservation, problem-solving, decisions and work should be informed by knowledge (Deming, 1982; Joiner, 1994; Scholtes, 1998; Seddon, 2003). Leaders should better understand how to seek and use the best knowledge that is available at a given point in time.

4.3. Can the Theory of Variation Be Usefully Applied to Natural Systems?

Holling and Meffe (1996: 335) state that "*effective natural resource management that promotes long-term system viability must be based on an understanding of the key processes that structure and drive ecosystems, and on acceptance of both the natural ranges of ecosystem variation and the constraints of that variation for long-term success and sustainability*".

The principles of understanding variation in systems was heavily advocated by Deming (1982) based on the early work of Shewhart (1931). Their approaches followed observations that management decision-making tends to follow an imprecise or poor understanding of data, trends and true levels of performance. In practice this is observed in forms of behaviour such as reacting to apparent changes which only represent background "noise" in the data, or ignoring fundamental changes in data (either by not perceiving or misinterpreting patterns), or by making comparisons of variance between one figure and another (typically annual comparisons for example) without understanding the pattern of data between such points. The systemic issue with this type of faulty thinking is that decisions are made which worsen performance rather than enable it to be improved (Deming, 1994; Wheeler, 2000).

As technically trained people, conservation practitioners have an appreciation for the need for data to inform how interventions are progressing (Black et al., 2011). Nevertheless this understanding needs to be adapted to take account of longitudinal patterns of distribution, based on an understanding of variation in the natural systems in which conservationists work. Holling and Meffe (1996: 334) suggest a "Golden Rule" in natural resource management: "*to retain critical types and ranges of natural variation in ecosystems. That is, management should facilitate existing processes and variabilities rather than changing or controlling them*". Presently, longitudinal analyses in conservation are unusual and the use of analyses of variation in conservation management is rare. Although this might suggest that understanding variation in patterns of data over time is not important in conservation this is not the case. It is notable that the most successful species recovery programmes are those which have long-term datasets and are based on a growing knowledge of the situation for the species, including the previously mentioned Black-footed Ferret, Florida Manatee, California Condor and Mauritius Kestrel, as well as Przewalski's Horse (*Equus przewalskii*), the Pink Pigeon (*Columba mayeri*) and the Peregrine Falcon (*Falco peregrinus*), to name a few (Caughley, 1994; Clark et al., 1994; Caughley & Gunn, 1996; Cade, 2003; Black & Groombridge, 2010; Black et al., 2011).

The advantage of analyzing variation in data is that it enables the leader to rationalise the unknown aspects of the system within the noise of the data presented. For example, an intervention to conserve tigers needs to be based upon an understanding of changes in the population of tigers within the wider ecosystem, including human-tiger conflict. One area of tiger mortality concerns killing by local farmers (in self-defence, to protect livestock or sometimes as retribution). Observation of variation in tiger numbers as well as other measures (such as number of tigers killed) will indicate the "health" of the system, particularly if compared to data such as number of livestock attacks or number of attacks on humans by tigers. Interventions might include the education of local people on personal safety or livestock security, plus the capture and relocation of reported "problem" tigers in the vicinity of villages (Inskip & Zimmermann, 2009). By studying variation in data over time the conservation leader can examine if trends of improvement occur (i.e. reduction in conflicts with humans and livestock) and then examine whether those changes in the data can be attributed to changes in method (e.g. new practices such as farm workers operating in pairs, or early removal of problem tigers away from the vicinity of villages). If no changes are detected, despite the conservation effort, then new methods may need to be explored, such as the construction of fencing. Background changes in the system, such as natural tiger population fluctuations, migration and climatic effects, if systemic, will be reflected in the noise (natural variation) in the data and need not be measured in detail. Similarly the impact of fundamental background changes, such as a collapse in wild deer prey populations would be signalled in the data. For the practitioner, there is no need for frequent collection or analysis of these additional data until a problem is signalled in the system by the existing metrics of concern. In a resource-constrained sector such as wildlife conservation a reasonable indicator of change in relation to intervention is sufficient; it is suggested that good indicators should track outcomes rather than just output (Kapos et al., 2008). The data (and its pattern of variation) should inform the methods of work which are undertaken.

The pitfalls of the logframe approach to conservation evaluation have been highlighted (Rogers & Williams, 2010). Additionally there is the risk, where leaders are encouraged to satisfy the logframe approach, that they tend to identify measures which may seem perfectly plausible (e.g. number of people trained), but which are difficult to link back to change in the system (for example to improve conservation of tigers) and therefore the metrics might not be relevant. Instead, leaders should focus people on a meaningful evaluation of biodiversity outcomes using empirical measures relating to the purpose of their programme and an understanding of the system rather than logging project activities.

The opportunity provided to the conservation leader by understanding the theory of variation is that they can apply the same thinking to the way they lead human organizations (i.e. their team, organization or wider community) as a response to observable variation in results. In other words, the work that is done can be related to the results observed in the ecosystem. Conservation managers should identify relevant conservation performance indicators and manage the "system conditions" (Seddon, 2003) which help or hinder improvements in the effectiveness of conservation work. As an alternative management perspective and a better way of working (Deming, 1982), the Systems Thinking approach can enable conservation managers to see through the bureaucracies of command structures and instead focus on the needs of species and ecosystems (Black et al., 2011). By applying the theory of variation to existing data sets, leaders can encounter a much better understanding of longitudinal trends and the relative status of today's results in the context of what has occurred before and what is likely to occur tomorrow. Without understanding variation, any examination of cause-and-effect will be initiated from trivial changes caused by noise, which means that effort is wasted and the leader's understanding becomes even more obscured (Wheeler, 2000). Conversely if data changes are detected from an understanding of natural variation, these infer real changes in the system, including when they occur, so prompt an examination of "why", and subsequent problem solving. This approach adds knowledge.

4.4. Would an Understanding of Human Psychology Usefully Assist Conservation Work?

When asked to consider the most important factor in successful conservation, Dr. Ulysses Seal, a noteworthy conservation professional and founding Chairman of the IUCN Conservation Breeding Specialist Group stated: "*the one common feature that many successful conservation projects have is a charismatic and inspirational leader that has a clear vision, can motivate the staff and can manage morale*" (C.G. Jones, pers. com). Seal's comments suggest that leaders need to focus attention on empowering their teams. To do this effectively requires an element of trust (Black et al., 2011). People must be able to trust that the leader will tolerate genuine mistakes in pursuit of agreed goals if they are to be truly empowered to make decisions on behalf of the organization (Bass & Avolio, 1993; Kouzes & Posner, 2007). They also need to feel that they can talk openly and be encouraged to say what they are thinking in the knowledge that they will not be penalized for saying "the wrong thing". This requires the leader to be willing to receive positive criticism of their *own* performance matched to staff expectations.

The command-and-control paradigm carries misplaced assumptions about people which need to be replaced (Coppin & Barratt, 2002). For example, presumed cause-and-effect links between praise and motivation or sanctions and improvements in performance have been demonstrated as flawed by numerous behavioural theorists (Jacobs, 2009; Scholtes, 1998; Seddon, 2003) and more recently by combinations of psychology and neuroscience (Jacobs, 2009). Similarly unfounded are assumptions that organisations operate as the sum of their parts. It is incorrect to expect that goals, targets and objectives can be set for individuals or teams such that the sum of those goals and targets will result in success (Deming, 1982; Joiner, 1994; Scholtes, 1998). Instead, in practice, various interrelationships or constraints operating between elements will distort overall performance, for example good performance in one area may consume resources that were expected by another area, which itself would therefore underperform, and so on (Bertalanffy, 1969; Senge, 1990). In wildlife conservation this is often expressed in goal displacement or uneven allocation of funding and resources within or between conservation programmes (Clark et al., 1994).

Numerous examples of failures in conservation leadership thinking relate to goal-setting (Clark et al., 1994). For the Po'ouli, a Hawaiian forest bird, goals set to fence-off protected areas to enable removal of invasive species diverted most programme resources, such that little was available to identify the needs of the bird itself (Powell, 2008). The result was successful creation of protected, restored habitat, but loss of the Po'ouli, the very species for which the habitat was intended. In an alternative situation, during the early years of the Black-footed

Ferret programme, efforts to achieve goals relating to captive breeding of these mammals were highly successful and became increasingly well-resourced, yet the programme failed to build knowledge to support successful release and survival of ferrets in the wild; many animals were released, but few survived (Clark et al., 1994). In both these cases people pursued goals in competition with peers; fundamentally compromising the overall purpose of the conservation programmes concerned (Black & Groombridge, 2010).

Improvement starts when people have a common sense of purpose (Deming, 1982). Leaders should remind people that their efforts are worthwhile; a world in which people and wildlife co-exist is worth striving towards. In this sense conservation leaders are presented with a great opportunity: a workforce which not only has technical skill, scientific knowledge or expert understanding, but also high levels of passion and commitment (Black et al., 2011). A leader who understands psychology and gives team members a sense of purpose and control over their work (Herzberg, 1976; Jacobs, 2009) can engage those people to utilize their capabilities and enthusiasms, which would be a highly efficient use of a conservation organization's human resources.

5. Implications for Leaders

Our analysis raises a number of implications for leaders of biodiversity conservation and recovery, which are transferable to any other sector experiencing a dynamic climate of uncertainty and change. **Table 1** summarizes the change in perspective which leaders need to undertake (Kohn, 1986; Coppin & Barratt, 2002; Seddon, 2003; Black et al., 2011) to switch away from traditional leadership paradigms to a Systems Thinking perspective aligned to Deming's (1994) System of Profound Knowledge. These perspectives are an important start point

Table 1. Contrasting leadership by Systems Thinking with leadership by traditional command-and-control.

	A Systems Thinking Leader will seek to develop an approach informed by the perspectives below	Traditional approaches below indicate an absence of Systems Thinking
Appreciation of a system		
Attitude to customers/users	What matters to customers/users?[a] Cooperative/partnership approach. Value, speed and reliability	Contractual approach to users: adversarial, price based, "you fit with what we offer"
Attitude to suppliers	Co-operative/partnerships. Value, speed and reliability based: work together long-term, eliminate time/cost from supply chain	Contractual approach to suppliers: adversarial, price-based, "look how much we'll squeeze you"
Organisation Design	Outside-in, derived from core work processes, self-managing teams	Top-down hierarchy, functional procedures, depend on individuals
Understanding psychology		
Ethos	Learning, team-based, sharing, integrity, vision	Control, individualism, "politics" and rivalry
Attitude to employees	Trust and responsibility. People are the solution, with huge potential for growth	People are the problem, their potential is limited, "carrot and stick"
Decision Making	Integrated with workers	Separated from workers
Leadership	Inclusive, situational, based on expertise	Exclusive, fixed. Based on position/hierarchy/seniority
Using theory of knowledge		
Communication	Based on knowledge, understanding and improvement, available to those best placed to make the decision	Based on passing information, limited to managers, top down.
Learning and Development	An investment, for all, critical for success and improvement.	A cost, privilege of the few
Understanding variation		
Measurement	"What & Why" focus: related to purpose, capability, variation, "lead" and "lag" measures	"What" focus: output, targets, standards, related to budget
Pay and Reward	Reward capability and achievement	Reward attendance

Note: a. In conservation this means species, ecosystems, landscapes, and local human communities dependent upon the ecosystem.

for managers to engage with a new set of mental models for leading teams, projects and programs. Leadership relates to how the leader perceives situations. Perceptions need to be informed by knowledge of systems, and leaders need to be able to inspire others to take up the mantle of leadership.

5.1. Leadership Is Not Just Contextual but Concerns How Leaders Perceive Situations

Bennis (2009: 44) suggests that "[leaders are]… *those who master the context and* [managers are] *those who surrender to it*". Tannenbaum and Schmidt (1973) propose that the approach adopted by a leader depends on the mix of three variables: the person's own background and leadership tendencies; the willingness or not of the subordinates involved to accept responsibility; and the peculiarities of the situation in which they are working.

Among contemporary leadership theory, the situational relevance of leadership is well established (Hersey & Blanchard, 1969). Situational leadership approaches focus upon (i) understanding the task and (ii) the person (i.e. the subordinate). Nevertheless Deming's ideas take this thinking further, moving beyond a simplistic notion of people and task. Leadership instead should combine an understanding of variation and psychology (Deming, 2013). If an understanding of variation suggests that a system is stable, the leadership approach should be quite different from that in a situation where the system is unstable. A poor leader tampers with the system and exacerbates problems: this is an established phenomenon demonstrable in the ways that performance variation is managed, or mis-managed (Shewhart, 1931; Deming, 1982). Furthermore, confusion between the two states of stability and instability leads to calamity: accelerated breakdown in capability, a reduction in performance and an increase in costs (Deming, 1982).

By this notion, coaching in a time of crisis would be nonsensical, even if the person being coached feels that they would benefit by the experience. This is exactly the case if a situation is unstable (in terms of variation) for example, as experienced in the conservation world with situations of declining, threatened populations or incidences of rapidly accelerating population growth in invasive species. In these occurrences the priority is to achieve a more stable state (even as a short-term solution such as a captive bred population), either by directing people to deal with the relevant priorities or by delegating priority actions to people who are available, competent and capable. The converse is also true; once a system is stable, managing in "crisis mode" would be a recipe for demotivation and disaster. Instead, in a stable system, learning and improvement should be the priority. In the case of the attempted conservation of the Po'ouli, competent people were constrained by policy over many years to carry out menial survey work which generated little value or knowledge (Powell, 2008). Not surprisingly, successive teams became demoralized and less inclined to challenge management priorities. Even when a new, more challenging team was installed in the latter years of the birds' survival, they were held back by an ingrained culture of "cannot do", rather than "can do".

Essentially, more effective leadership is not just about adapting an approach to its context or coaching and involving people as best as possible; it is instead about having a new leadership paradigm (or "mental model") that steers how we design and manage work (Coppin & Barratt, 2002; Seddon, 2003). This involves leaders developing personal mastery in the way that they see and act in the world of work. Mastery is a discipline that goes beyond competence, skills and a sense of values, towards integrated proficiency based on a profound sense of purpose and clarity of perception (Senge, 1990); an ability to perceive context alongside an ability to manage it proactively. In this sense an effective leader needs to apply both transformational and transactional leadership (Bass & Avolio, 1993) as appropriate for different individuals on different tasks at different points in time, but additionally needs to perceive situations in the context of what is happening in the wider system.

5.2. Leaders Need to Use Knowledge Informed by an Understanding of Systems

In common contemporary leadership thinking McGregor's (1960) Theory Y type paradigm predominates, assuming staff are fundamentally pleased to work and can be motivated by their work. The theory Y leader believes that people have self-control and are capable of solving problems by themselves, if given the means and the freedom to do so. The transformational leadership paradigm adopts this perspective, encouraging leaders to devote time and energy to finding ways to release the creative potential of the people for the betterment of the organization. Such leaders focus their attention on empowering those who work with them. True power requires people to have knowledge and the ability to act on the basis of that knowledge (Seddon, 2003). The leader must be able to tolerate genuine mistakes and give people the confidence to talk openly in order to improve learning and understanding (Senge, 1990). The leader must be disciplined in seeing the system, rather than seeing things as "right" or "wrong". This enables fundamental problems with work (i.e. the system) to be separated from problems of capability (i.e. the system as it relates to training), or problems of negligence (i.e. a weakness on the part of a person) in the workforce (Black et al., 2011).

Definitive answers (or facts) may be the preferred currency of conservation scientists, but are not always accessible: "*There is no such thing as a fact concerning an empirical observation. Any two people may have different ideas about what is important to know about any event*" Deming (1994: 105). One example is the debate concerning the possible survival of the Ivory-Billed Woodpecker (*Campephilusprincipalis*) in Louisiana and Arkansas, USA (Fitzpatrick, 2005; Sibley, 2006; Roberts et al., 2010). Investment on protection and management of habitats (properly designed in line with the needs of species and ecosystems) would support the likelihood that the species will persist in the future. Neglecting such investment will most certainly doom the species to extinction. This may be self-evident, yet the debate in relation to this species continues, driven by professional or economic interest (both elements of the wider "system"). Ultimately, conservation loses out; a win/lose mentality eventually sees everybody lose (Deming, 1994). Biodiversity does not have its own voice; if human advocates in the conservation community lose ground through in-fighting (however constructively, honorably or scientifically may it be presented) then there is little hope of a breakthrough in biodiversity conservation. Leaders must seek collaborations for breakthroughs in conservation management: building knowledge, rather than rhetoric, ideology or technical preference (Black et al., 2011).

5.3. Leaders Need to Inspire the Next Generation

The challenge of biodiversity conservation is not going away. This level of challenge is common for leaders in other industrial, commercial, service and public sectors. Conservation leaders should be conscious of their need to inspire and develop the leaders in the next generation who will manage and enable improvements that have a positive impact on global biodiversity. Current leaders must become aware enough to avoid management approaches that deny employees dignity and self-esteem since this will only serve to smother intrinsic motivation of their workforce (Deming, 2013). Similarly, the structures and incentives for developing conservation careers must be congruent with the new philosophy. Deming (2013) emphasizes that where extrinsic motivators (higher pay, promotion criteria, higher ratings, career progression pathways) result in requirements for people to do what they know to be wrong, it robs them of dignity and self-esteem, and motivation dwindles further. The psychological impact of bad management practice carries the risk of alienating the potential next generation of conservation leaders, or at least may cause ineffective practice to be embedded *ad infinitum*.

Good habits of leadership, understanding and managing the system, will necessitate a leader to increase the capability and insight of their teams to see and understand the system. This provides the leader with an opportunity to build a legacy of good thinking in the people who may continue to take responsibility for the work in the future. Leaders need to recognize that leadership development is self-development (Kouzes & Posner, 1999); there is no one "best style" of leadership. More fundamentally it is about finding the best way to think and act. To be an effective leader requires recognition that there is always room for improvement. Kotter (1996) states that within the changing world in which we now live an effective leader must be both student as well as teacher: always hungry to learn more about how to enthuse, engage and empower those who follow.

6. Conclusion

Conservationists are agents of change, attempting to influence natural and social systems for the good of threatened species and ecosystems. The failure to meet the Convention on Biological Diversity 2010 targets (CBD, 2004; Butchart, 2010) illustrates that, aside from the earnest effort applied with limited resources, current approaches to managing conservation are not delivering the level of improvement and recovery that is required in the face of increasing global threats. This demands a new paradigm in conservation thinking: a new focus on the purpose of saving species and ecosystems and a common sense of purpose held by the variety of people and organizations who are engaged in the work. Continuous learning is particularly important for effective conservation, but it demands a sympathetic and proactive management culture. Although emerging practical concepts such as "evidence-based conservation" (Sutherland et al., 2004) offer better ways of encouraging learning and a focus on practices which improve results, the enabling of conservation organizations to engage with good practice is the job of leadership. In this sense it is leadership, as a function of perception, thinking, skills, communication, behaviors and management practices, which can have a profound effect on the results achieved by people working in organizations, and certainly those within the wildlife conservation sector.

Systems Thinking is well-matched with the demands of biodiversity management (Sterling et al., 2010) and contrasts starkly with the predominant command-and-control approaches found in the conservation sector (Holling & Meffe, 1996). Furthermore, the failures and ineffectiveness observed in command-and-control approaches are a symptom of the unsustainable attempts to resolve problems of biodiversity decline. These symptoms can also be observed in other sectors where similar leadership challenges pervade. A Systems Thinking approach based upon a broad understanding of the four areas of competence emphasized by Deming (1994); understanding systems, the theory of variation, psychology and the theory of knowledge, would enable leaders to positively influence program performance. In conservation, this offers greater beneficial impacts on biodiversity recovery; an approach served by maintaining a focus on the needs of species and ecosystems. As agents of change, that has potentially far-reaching implications for the planet, conservation leaders would be well advised to consider how they can apply Deming's System of Profound Knowledge to their vocation.

We suggest that leaders use Systems Thinking to be best-placed to examine and test practices, using knowledge of ecosystems and people. Deming's (1994) leadership paradigm, the System of Profound Knowledge, sets out two candid responsibilities for leaders: i) to solve problems and; ii) to help their people in every way possible (Mauro, 1999). Leaders who apply Deming's System of Profound Knowledge would be well placed to encourage effective work, in pursuit of a clear vision. In addition, such leaders would be more adept at working within organizational structures, and able to manage processes and people within the wider context.

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