The devil in the (demographic) detail

The *Dispatches* piece "Infectious cancer decimates Tasmanian devils" (*Front Ecol Environ* 2006; **4(2)**: 65) and the *Nature* articles on which it was based (Dennis 2006; Pearse and Swift 2006) highlight current research aimed at saving the endemic Tasmanian devil (*Sarcophilus harrisii*) from the deadly facial lesions known as devil facial tumor disease (DFTD). Researchers have committed considerable time and effort to determining the agent responsible for the disease, with new evidence pointing to transmission via allograft of infectious cells between combative individuals (Pearse and Swift 2006). However, the suggestions of imminent extinction and the speculation regarding the role of toxins or deforestation in instigating and promulgating DFTD are unsupported by empirical evidence and ignore the fundamental dynamics of the devil population.

Regardless of the agent involved, the high transmission rates between individuals fighting over scavenged food resources must be investigated within a framework of population dynamics. Previous modelling of the devil population (Bradshaw and Brook 2005) supports the strongly density dependent nature of DFTD transmission and this, along with historical and anecdotal information, suggests that the devil population in Tasmania has undergone (and subsequently recovered from) at least three catastrophic declines due to disease in the past two centuries. Indeed, there is evidence that populations expanded considerably following agricultural deforestation, when livestock carcasses became a common feature of the landscape (Bradshaw and Brook 2005). A classic pattern of extreme fluctuation in abundance generally emerges when the transmission dynamics of the pathogen or agent responsible is density dependent (eg Davis *et al.* 2004) – the disease has a lower rate of infection when the contact rate between individuals declines (Lafferty and Gerber 2002). As such, we argue that this scavenging carnivorous marsupial is adapted to cope with a high prevalence of disease due to the strong selective pressure exerted by its immunologically challenging feeding strategy, evolving a surprisingly early age of senescence for a mammal of its size (up to 11 kg).

While this built-in resilience does not necessarily nullify the risk of extinction, given the possibility of other new mortality sources and Allee effects at low densities (Bradshaw and Brook 2005), it does cast doubt on the more ominous predictions of imminent extirpation. We suggest that while attempts to establish disease-free zones (Dennis 2006) could reduce disease prevalence and provide added conservation safeguards, a potentially more efficient approach would be to reduce densities immediately by removing infected individuals from the entirety of the species' range. This would have the dual benefit of reducing the likelihood that individuals will encounter diseased conspecifics and mitigating intraspecific competition induced by conflict over limited shared resources. Thus, once exposure probabilities are pushed below a certain threshold, "extinction" of the infectious agent becomes more likely.

Current pilot studies aimed at reducing densities in small disease-free refugia (Dennis 2006) may only provide a temporary solution, given the possible maintenance of the disease outside these zones. We therefore recommend a research program that measures the degree to which transmission rates are modified by population density. This could be achieved by the comparison of disease dynamics in (1) areas receiving no density reduction (controls), (2) areas where only diseased devils are removed, and (3) areas where density is reduced through the random removal of individuals. An experiment of this scope and magnitude would provide information essential to parameterize spatially explicit models that could identify the areas most in need of manipulation.

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Extreme climatic events in ecological research

Alterations in the magnitude and frequency of extreme events (IPCC 2001) pose new challenges to ecosystem resilience and socioeconomic systems. It is not surprising, therefore, that the debate about climate change has expanded from an analysis of trends to an interest in extreme events. However, neither the "event"-character of climatic processes nor the quantification of "extremeness" is well established in this debate.

In a recent article, Holmgren *et al.* (*Front Ecol Environ* 2006; **4(2)**: 87–95) associate extreme climatic events with the El Niño Southern Oscillation, although they are aware of its relative predictability with return intervals between 3 and 6 years (McPhaiden 2004). The recurrent nature of this oscillation immediately raises the question: What should be considered extreme? As a disturbance ecologist interested in ecosystem dynamics, I would argue that we need to clarify the concepts of event and extremeness, in order to collectively profit from event-based ecological research dealing with several orders of magnitude in the life spans of response communities.

First, a discrete event is distinguished from a continuous process by its abruptness, no matter whether the event is recurrent, expected, or normal (White and Jentsch 2001). Abruptness of an event is a function of magnitude over duration, which is best described relative to the life cycles of the organisms in focus. Thus, El Niño events may be perceived as climate driven weather events by many higher organisms in the relevant ecosystems. Their life spans range from weeks to centuries, so that some members of the system experience the event only once and others several times. The concept of discrete events suggests that they are abrupt relative to growth rate and succession of the ecosystems in which they occur. Using such relative currency to express frequency allows comparison among ecosystems.

Second, I believe that extremeness of events can be determined by statistical extremity with respect to a historical reference period (extreme value theory). However, predicting future climatic scenarios, we are faced with two different qualities of extremeness; (1) an increase in the probability of occurrence of a maximum or minimum of a given climatic parameter (frequency of multi-event), such as temperature, and (2) a novel crossing of the observed minimum or maximum of a climatic parameter (magnitude of single event), such as length of drought period in a given area. In this context, extremeness of an event is described independent of its effects on organisms. Thus, the question remains, whether a particular El Niño-caused event such as cold, heavy rainfall, or drought meets either of the two criteria of extremeness.

Remarkably, the farther back we look in time, the more extremes we observe. The definition of extreme is therefore historically contingent. Also, the Earth had periods of relative stability and relative change, and there were periods of rapid resetting of "extremeness". Are we now in a period that is even more rapid in that resetting? An organism's range of tolerance is the only condition that would answer this question, and it might be different for different organisms.

Science and society urgently need to advance research on extreme events and their consequences for ecosystems by collecting evidence on their effects through long-term observations and short-term experimental studies in various ecosystems and on various scales of time and magnitude.

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Stopping *Caulerpa* sales on eBay

Walters *et al.* (*Front Ecol Environ* 2006; **4(2)**: 75–79) eloquently highlight the need to limit internet sales of *Caulerpa* species and specifically call for online marketplace eBay to halt sales of this potentially invasive genus. We would like to offer a bit of background on our work in this area.

In the summer of 2004, Sea Studios Foundation (SSF) began working with eBay to limit trafficking of invasive species as part of National Geographic's *Strange Days on Planet Earth* series (www.pbs.org/strangedays). SSF approached eBay for a number of reasons. With more than 6 million listings added daily, this marketplace reaches an enormous dom-estic and international audience, making every home a potential port of entry for invasive species. Until the *Strange Days* initiative, eBay had no policy for curtailing the trafficking of invasive species, but was happy to work with experts in the field to address this issue.

SSF established a productive dialogue and working relationship between eBay's Trust and Safety Department and the USDA's Animal and Plant Health and Inspection Service (APHIS). Together, the group wrote and posted new invasive species trafficking policies for the eBay website (eg http://pages.ebay.com/help/policies/plantsandseeds.html).

In addition, APHIS compiled for eBay an ongoing list of federally regulated invasive species most likely to be found for sale on the internet. The site then developed, field-tested, and fine-tuned methods to halt the listing of these species. For example, we included *Caulerpa taxifolia* on the list and, as Walters *et al.* point out, this particular species listing is not available on eBay. Other prohibited species include giant *Salvinia* spp, giant hogweed (*Heracleum mantegazzianum*), cape tulip (*Homeria* spp), *Hydrilla*, Chinese water spinach (*Ipomoea aquatica*), and mosquito fern (*Azolla pinnata*). In addition, APHIS has recently completed a pre-assessment of the genus *Caulerpa*, identifying the risks that its 84 species (and assorted infraspecific taxa) present to ecosystems.

One of the great challenges in halting the internet trafficking of invasive species is the myriad names given to particular species. As we continually augment our lists, we welcome research such as that conducted by Walters *et al.* We thank the authors for bringing attention to this issue and for highlighting additional species to consider for federal regulation and addition to our existing *Caulerpa* filters. With continued vigilance, we can all be part of the solution.

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War of the roses: towards a holistic view of invasive species management

I read with interest Larson's recent article (*Front Ecol Environ* **3(9)**: 495–500) on a thought-provoking initiative that introduces the concept of responsibility through demilitarizing the language that is commonly used in invasive species research and control. The review challenges managers, researchers, and theorists interested in this topic to accept that, as Larson rightly points out, humans also need to be managed as they are an integral part of the problem. This is achieved by illustrating how military metaphors commonly used in discussing invasive species can lead to (1) inappropriate perceptions of invasives and (2) loss of scientific credibility. By demilitarizing the language used in the debate and management of invasive species, Larson is proposing that we "de-demonize" the invasive species in question, because by demonizing them we are effectively distancing ourselves from any blame. Indeed, in many instances, distancing ourselves as integral components of ecosystems has led directly to the conservation problems associated with invasive species that we now face.

However, the debate is not a simplistic, one-way, mechanistic process where one action leads to a specific outcome (Yodzis 2000). Therefore, bearing in mind the complexity of these issues, it may be imprudent to dismiss entirely the use of military metaphors in the debate. This is because there are instances where invasive species have been controlled using a militaristic approach in the design, implementation, and publication of the results, and have been removed from sensitive ecosystems (Bester *et al.* 2002). For instance, in the Marion Island ecosystem, the invaders (feral cats) were directly responsible for the extinction of native species and therefore a reduction in biodiversity (Bester *et al.* 2002). The success of the cat eradication program on Marion Island can be attributed to a militaristic approach that included a staged process of high-level research (reconnaissance), experimentation with different control measures (planning), and implementation of the methods (execution). Consequently, while I agree that removing military metaphors from the language of invasive species management promotes an inclusive and novel approach to the debate, I feel that the complete eradication of a military philosophy may not be entirely useful in such cases.

In order to embrace a more holistic approach to invasive species management, it seems prudent that in our ultimate bid to conserve as much biodiversity as possible we, as conservationists and ecologists, should not dismiss the contribution that military metaphors have made in the success of management programs. Instead, both philosophies should be integrated into the debate. In fact, debate is of vital importance in understanding those processes that are threatening biodiversity, because with debate comes the airing and recognition of contrary views which, with a little luck and perseverance, may lead to compromise and understanding from the extreme sides of that debate. Such collaboration must (hopefully) lead to all parties pooling their resources (in this instance intellectual) towards the common goal of biodiversity conservation.

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Bester MN, Bloomer JP, van Aarde RJ, et al. 2002. A review of the successful eradication of feral cats from sub-Antarctic Marion Island, Southern Ocean. *S Afr J Wildl Res* **32**: 65–73.
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Erratum

Messing RH and Wright MG. *Front Ecol Environ* **4(3)**: 132–40. Photo credits for Figure 5 were reversed: Figure 5a should be "Courtesy of R Heu" and Figure 5b should be "© Jack Jeffrey".

Hodder *et al. Front Ecol Environ* **4(3)**: 162–63. There was an error in Box 3 of Panel 1. The calcium carbonate formation/dissolution equation is not one of equilibrium as shown. The statement that calcium carbonate is dissolved is incorrect; rather, reduced pH and lower carbonate saturation in the ocean means that fewer carbonate ions are available to build skeletons. A corrected version of Panel 1 is available at www.first2.org

Briggs JM, *et al. Front Ecol Environ* **4(4)**: 180–88. In the legend to Figure 7, the third sentence should read: Maize pollen was found in this layer (see Table 1).

Dodds W. *Front Ecol Environ* **4(4)**: 211–17. In Figure 2, the dotted line should be "mineralization" and the dashed line should be "net uptake". The lower left graph in Figure 3 does not use data from the Atchafalaya River. Corrected graphs are available in the online version of this page.

