

Marine Science Review - 158

Miscellaneous publications



In this review:

- A. Recent articles with no abstract available
- B. Recent publications available online
- C. Recent articles with abstracts

A. Recent articles – no abstract available

Kelly, J.P. **The seduction of the appellate body: Shrimp/Sea turtle I and II and the proper role of states in WTO governance.** *Cornell International Law Journal* 38(2): 459-491, 2005.

Chavanich, S., Koeyin, P., Viyakarn, V., Piyatiratitivorakul, S., Menasveta, P., Suwanborirux, K., and Poovachiranon, S. **A tunicate from a Thai coral reef: a potential source of new anticancer compounds.** *Coral Reefs* 24(4): 621, 2005.

Blunt, J.W., Copp, B.R., Munro, M.H.G., Northcote, P.T., and Prinsep, M.R. **Marine natural products.** *Natural Product Reports* 23(1): 26-78, 2006.

Fischetti, M. **Protecting New Orleans.** *Scientific American* 294(2): 64-71, 2006.

Brunner, E. **Oily fish and omega 3 fat supplements.** *British Medical Journal* BMJ, doi:10.1136/bmj.38798.680185.47 (published 24 March 2006), 2006.

B. Recent publications available online

Stankey, G.H., Clark, R.N., and Bormann, B.T. 2005. **Adaptive Management of Natural Resources: Theory, Concepts, and Management Institutions.** Gen. Tech. Rep. PNW-GTR-654. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 73pp.

Available at: http://www.fs.fed.us/pnw/pubs/pnw_gtr654.pdf

Notes: This report reviews the extensive and growing literature on the concept and application of adaptive management. Literature from a diverse range of fields including social learning, risk and uncertainty, and institutional analysis was reviewed, particularly as it related to application in an adaptive management context. The review identifies opportunities as well as barriers and concludes by describing steps that must be taken to implement adaptive management.

Walmsley, J. 2005. **Developing Objectives and Indicators for Marine Ecosystem-Based Management: International Review of Marine Ecosystem-Based Management Initiatives Throughout the World.** Oceans and Coastal Management Report 2005-09. Fisheries and Oceans Canada, Dartmouth, Nova Scotia. 54pp.

Available at: <http://www.dfo-mpo.gc.ca/Library/318539.pdf>

Notes: This report identifies ecosystem-based marine management initiatives throughout the world that have developed or were developing a system of objectives and indicators for management and reporting; evaluates the approaches taken to

develop objectives and indicators; and analytically compares the outcomes of each initiative to each other and to those of the Eastern Scotian Shelf Integrated Management (ESSIM) Initiative. Of the 23 ecosystem-based marine management initiatives identified in this review, only nine have developed objectives and/or indicators and none have yet achieved full implementation. The report provides lessons learned and highlights the approaches to develop objectives and indicators, the predominant focus on ecosystem objectives *vs.* human use objectives, and the variation in terminology used in each initiative.

UNEP (2006). **Ecosystems and Biodiversity in Deep Waters and High Seas.** UNEP Regional Seas Reports and Studies No. 178. UNEP/ IUCN, Switzerland. 58pp.

Available at: http://www.unep.org/pdf/IUCN_Report_16June06.pdf

Notes: Swift and wide ranging actions are needed to conserve the world's entire marine environment amid fears that humankind's exploitation of the deep seas and open oceans is rapidly passing the point of no return.

Joint Ocean Commission Initiative. 2006. **From Sea to Shining Sea: Priorities for Ocean Policy Reform.** 48pp.

Available at: http://www.jointoceancommission.org/press/press/release0613_assets/seareport.pdf

Notes: The Joint Ocean Commission Initiative, a collaborative effort of the U.S. Commission on Ocean Policy and the Pew Oceans Commission, produced this national ocean policy action plan in response to a senate request. The plan should serve as a guide for developing U.S. legislation and includes the top ten steps Congress should take to address the most pressing challenges, the highest funding priorities, and the most important changes to federal laws and the budget process to establish a more effective and integrated ocean policy.

C. Recent articles with abstracts

Tognelli, M.F., Silva-Garcia, C., Labra, F.A., and Marquet, P.A. **Priority areas for the conservation of coastal marine vertebrates in Chile.** *Biological Conservation* 126(3): 420-428, 2005.

Notes: In the past decade, there has been growing concern about the rapid degradation of marine ecosystems due to anthropogenic causes. Consequently, identifying priority areas for the conservation of marine biodiversity has become a crucial conservation issue. Taking into account the influence of human population density, we performed complementarity analyses to identify priority areas for the conservation of all coastal marine vertebrate species in Chile (265 species), and evaluated congruence among the different target groups. The distribution ranges of all species were digitized in a geographic information system and analyses were performed on latitudinal bands of 0.5°. Our results show that 12 latitudinal bands (~16% of all latitudinal bands) are necessary to conserve at least one population of each species. Ten of these bands are irreplaceable, whereas two are flexible. Many of the irreplaceable sites lie within areas that have high human population density. In order to conserve all threatened and endemic species, six and three latitudinal bands are needed, respectively. Four latitudinal bands are needed to represent all species of fish, reptiles, and mammals, whereas nine bands are needed to protect all bird species. Taking flexible sites into account, reserve networks that meet the minimum representation goal for each taxonomic group, and for threatened and endemic species, represent subsets of the 12 latitudinal band network selected for all species. Spatial congruence among reserve networks selected for each target group was relatively low and only significantly higher than random in 9 out of 21 pairwise comparisons. However, with the exception of reptiles, conservation areas selected for different surrogate groups represented other groups relatively well, compared to randomly selected sites.

Mahowald, N.M., Baker, A.R., Bergametti, G., Brooks, N., Duce, R.A., Jickells, T.D., Kubilay, N., Prospero, J.M., and Tegen, I. **Atmospheric global dust cycle and iron inputs to the ocean.** *Global Biogeochemical Cycles* 19(4): art. GB4025, 2005.

Notes: Since iron is an important micronutrient, deposition of iron in mineral aerosols can impact the carbon cycle and atmospheric CO₂. This paper reviews our current understanding of the global dust cycle and identifies future research needs. The global distribution of desert dust is estimated from a combination of observations of dust from in situ concentration, optical depth, and deposition data; observations from satellite; and global atmospheric models. The anthropogenically influenced portion of atmospheric desert dust flux is thought to be smaller than the natural portion, but is difficult to quantify due to the poorly understood response of desert dust to changes in climate, land use, and water use. The iron content of aerosols is thought to vary by a factor of 2, while the uncertainty in dust deposition is at least a factor of 10 in some regions due to the high spatial and temporal variability and limited observations. Importantly, we have a limited understanding of the processes by which relatively insoluble soil iron (typically ~0.5% is soluble) becomes more soluble (1-80%) during atmospheric transport, but these processes could be impacted by anthropogenic emissions of sulfur or organic acids. In order to understand how humans will impact future iron deposition to the oceans, we need to improve our understanding of: iron deposition to remote oceans, iron chemistry in aerosols, how desert dust sources will respond to climate change, and how humans will impact the transport of bioavailable fraction of iron to the oceans.

Mayer, A.M.S. and Hamann, M.T. **Marine pharmacology in 2001-2002: Marine compounds with anthelmintic, antibacterial, anticoagulant, antidiabetic, antifungal, anti-inflammatory, antimalarial, antiplatelet, antiprotozoal, antituberculosis, and antiviral activities; affecting the cardiovascular, immune and nervous systems and other miscellaneous mechanisms of action.** *Comparative Biochemistry and Physiology -- Part C* 140(3-4): 265-286, 2005.

Notes: During 2001-2002, research on the pharmacology of marine chemicals continued to be global in nature involving investigators from Argentina, Australia, Brazil, Canada, China, Denmark, France, Germany, India, Indonesia, Israel, Italy, Japan, Mexico, Netherlands, New Zealand, Pakistan, the Philippines, Russia, Singapore, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Thailand, United Kingdom, and the United States. This current article, a sequel to the authors' 1998, 1999 and 2000 marine pharmacology reviews, classifies 106 marine chemicals derived from a diverse group of marine animals, algae, fungi and bacteria, on the basis of peer-reviewed preclinical pharmacology. Anthelmintic, antibacterial, anticoagulant, antifungal, antimalarial, antiplatelet, antiprotozoal, antituberculosis or antiviral activities were reported for 56 marine chemicals. An additional 19 marine compounds were shown to have significant effects on the cardiovascular, immune and nervous system as well as to possess anti-inflammatory and antidiabetic effects. Finally, 31 marine compounds were reported to act on a variety of molecular targets and thus may potentially contribute to several pharmacological classes. Thus, during 2001-2002 pharmacological research with marine chemicals continued to contribute potentially novel chemical leads for the ongoing global search for therapeutic agents for the treatment of multiple disease categories.

Martin, A. **The kaleidoscope ocean.** *Philosophical Transactions of the Royal Society of London [A]* 363(1837): 2873-2890, 2005.

Notes: Oceanic plant life is dominated by the microscopic phytoplankton. Regardless of the scale at which they are observed, they display striking heterogeneity in their distribution. At their most dramatic they paint colourful swathes across whole seas. A short history of observations of phytoplankton 'patchiness' is presented, illustrated with some of the many ideas put forward to explain it. Focus is then turned to the mesoscale, covering scales of roughly 1-500km. It is argued that the spatial variability seen in phytoplankton at these scales gives important information on the biogeochemistry of the ocean. In particular, interplay between the physical circulation and biological processes results in constantly shifting patterns that are strongly related to changes induced in phytoplankton production. It is thought that this physical influence may play a major role in controlling the rate at which new plant material (primary production) is generated in much of the world's oceans. Major questions yet to be addressed are also discussed including the difficulty of quantifying processes on the very limit of what we can model or observe and how these processes may change in response to and exert a feedback on future climate change.

Pukazhenthil, B., Comizzoli, P., Travis, A.J., and Wildt, D.E. **Applications of emerging technologies to the study and conservation of threatened and endangered species.** *Reproduction, Fertility and Development* 18(1-2): 77-90, 2006.

Notes: Sustaining viable populations of all wildlife species requires the maintenance of habitat, as well as an understanding of the behaviour and physiology of individual species. Despite substantial efforts, there are thousands of species threatened by extinction, often because of complex factors related to politics, social and environmental conditions and economic needs.

When species become critically endangered, *ex situ* recovery programmes that include reproductive scientists are the usual first line of defence. Despite the potential of reproductive technologies for rapidly increasing numbers in such small populations, there are few examples of success. This is not the result of a failure on the part of the technologies *per se*, but rather is due to a lack of knowledge about the fundamental biology of the species in question, information essential for allowing reproductive technologies to be effective in the production of offspring. In addition, modern conservation concepts correctly emphasise the importance of maintaining heterozygosity to sustain genetic vigour, thereby limiting the practical usefulness of some procedures (such as nuclear transfer). However, because of the goal of maintaining all extant gene diversity and because, inevitably, many species are (or will become) 'critically endangered', it is necessary to explore every avenue for a potential contributory role. There are many 'emerging technologies' emanating from the study of livestock and laboratory animals. We predict that a subset of these may have application to the rescue of valuable genes from individual endangered species and eventually to the genetic management of entire populations or species. The present paper reviews the potential candidate techniques and their potential value (and limitations) to the study and conservation of rare wildlife species.

Brown, M.V. and Fuhrman, J.A. **Marine bacterial microdiversity as revealed by internal transcribed spacer analysis.** *Aquatic Microbial Ecology* 41(1): 15-23, 2005.

Notes: A growing body of evidence suggests analysis of 16S rRNA gene sequences provides only a conservative estimate of the actual genetic diversity existing within microbial communities. We examined the less conserved internal transcribed spacer (ITS) region of the ribosomal operon to determine the impact microdiversity may have on our view of marine microbial consortia. Analysis of over 500 ITS sequences and 250 associated 16S rRNA gene sequences from an oceanic time series station in the San Pedro Channel, California, USA, revealed that the community in this region is composed of large numbers of distinct lineages, with more than 1000 lineages estimated from 3 clusters alone (the SAR11 clade, the *Prochlorococcus* low-B/A clade 1, and the *Roseobacter* NAC11-7 clade). Although we found no instances where divergent ITS sequences were associated with identical 16S rRNA gene sequences, the ITS region showed much greater pairwise divergence between clones. By comparison to our 16S rRNA gene-ITS region linked database, we were able to place an ITS sequences into a phylogenetic framework, allowing them to act as an alternative molecular marker with enhanced resolution. Comparison of SAR11 clade ITS sequences with those available in GenBank indicated phylogenetic groupings based not only on depth but also on geography, potentially indicating localized differentiation or adaptation.

Mansfield, B. and Haas, J. **Scale framing of scientific uncertainty in controversy over the endangered Steller sea lion.** *Environmental Politics* 15(1): 78-94, 2006.

Notes: Political debate about the endangered Steller sea lion turns on uncertainty about the cause of decline and lack of recovery of this marine mammal of the North Pacific Ocean. To shift the political terrain, different groups tried to shift the scale at which problems are framed. US regulators focused on localised interactions, environmental organisations highlighted the entire fishery management regime and the fishing industry focused on natural climate change within the North Pacific region. Because debate is about supposedly objective, scientific realities, these practices of scale framing take on particular significance in this case. Scientific understandings of individual problems are not outside the frame of scale practices, but instead there is a politics of scale around science. This case shows that using scale as a framing device is a powerful political strategy for dealing with uncertainty, because focusing on a particular scale presupposes certain kinds of solutions while foreclosing others.

Thebault, E. and Loreau, M. **The relationship between biodiversity and ecosystem functioning in food webs.** *Ecological Research* 21(1): 17-25, 2006.

Notes: Recent theoretical and experimental work provides clear evidence that biodiversity loss can have profound impacts on functioning of natural and managed ecosystems and the ability of ecosystems to deliver ecological services to human societies. Work on simplified ecosystems in which the diversity of a single trophic level is manipulated shows that diversity can enhance ecosystem processes such as primary productivity and nutrient retention. Theory also strongly suggests that biodiversity can act as biological insurance against potential disruptions caused by environmental changes. However, these studies generally concern a single trophic level, primary producers for the most part. Changes in biodiversity also affect ecosystem functioning

through trophic interactions. Here we review, through the analysis of a simple ecosystem model, several key aspects inherent in multitrophic systems that may strongly affect the relationship between diversity and ecosystem processes. Our analysis shows that trophic interactions have a strong impact on the relationships between diversity and ecosystem functioning, whether the ecosystem property considered is total biomass or temporal variability of biomass at the various trophic levels. In both cases, food-web structure and trade-offs that affect interaction strength have major effects on these relationships. Multitrophic interactions are expected to make biodiversity-ecosystem functioning relationships more complex and non-linear, in contrast to the monotonic changes predicted for simplified systems with a single trophic level.

Lessard, R.B., Martell, S.J.D., Walters, C.J., Essington, T.E., and Kitchell, J.F. **Should ecosystem management involve active control of species abundances?** *Ecology and Society* 10(2): U271-U293, 2005.

Notes: We review four case studies in which there is a risk of extinction or severe reduction in highly valued species if we ignore either, or both, of two ecosystem control options. "Symptomatic control" implies direct control of extinction risk through direct harvesting or culling of competitors and predators. "Systemic control" implies treating the causes of the problem that led to an unnaturally high abundance in the first place. We demonstrate, with a discussion of historically observed population trends, how surprising trophic interactions can emerge as a result of alterations to a system. Simulation models were developed for two of the case studies as aids to adaptive policy design, to expose possible abundance changes caused by trophic interactions and to highlight key uncertainties about possible responses to ecosystem management policies involving active intervention to control abundances. With reasonable parameter values, these models predict a wide range of possible responses given available data, but do indicate a good chance that active control would reverse declines and reverse extinction risks. We find that controlling seal (*Phoca vitulina*) populations in the Georgia Strait increases juvenile survival rates of commercial salmon (*Oncorhynchus* spp.) species, but that commensurate increases in hake populations from decreased seal predation could be a compensatory source of predation on juvenile salmon. We also show that wolf (*Canis lupus*) control and moose (*Alces alces*) harvest bring about a recovery in caribou (*Rangifer tarandus caribou*) populations, where simple habitat protection policies fail to recover caribou before wolf predation causes severe declines. The results help address a common problem in disturbed ecosystems, where controlling extinction risks can mean choosing between active control of species abundance or establishing policies of protection, and allowing threatened species to recover naturally.

McDougall, P.T., Reale, D., Sol, D., and Reader, S.M. **Wildlife conservation and animal temperament: causes and consequences of evolutionary change for captive, reintroduced, and wild populations.** *Animal Conservation* 9(1): 39-48, 2006.

Notes: We argue that animal temperament is an important concept for wildlife conservation science and review causes and consequences of evolutionary changes in temperament traits that may occur in captive-breeding programmes. An evolutionary perspective is valid because temperament traits are heritable, linked to fitness and potentially subject to intense selection in captivity. Natural, sexual and artificial selection can cause permanent shifts in temperament, reducing the diversity of temperament traits, diversity that may be critical to reintroduction success. Breeding programmes that ignore temperament risk leading the captive population towards domestication. Furthermore, shifts in temperament may involve alterations in linked morphological and physiological traits, and selection may even change functional relationships between traits. Captive-breeding programmes can reduce changes in temperaments by closely monitoring temperament traits, equalizing reproductive success between temperament morphs and using environmental enrichment to reduce captive stress. Under certain circumstances, knowledge about temperament may also provide a useful tool to optimize captive reproduction and to increase reintroduction success. Outside reintroduction programmes, temperament can mediate responses to human contact, hunting, exploitation, habitat fragmentation and disease transmission. Consideration of temperaments could strengthen both captive and wild conservation efforts.

Cadenasso, M.L., Pickett, S.T.A., and Grove, J.M. **Dimensions of ecosystem complexity: Heterogeneity, connectivity, and history.** *Ecological Complexity* 3(1): 1-12, 2006.

Notes: Biocomplexity was introduced to most ecologists through the National Science Foundation's grant program, and the literature intended to introduce that program. The generalities of that literature contrast with the abstract and mathematical

sophistication of literature from physics, systems theory, and indeed even of pioneering ecologists who have translated the concept into ecology. This situation leaves a middle ground, that is both accessible to ecologists in general, and cognizant of the fundamentals of complexity, to be more completely explored. To help scope this middle ground, and to promote empirical explorations that may be located there, we propose a non-exclusive framework for the conceptual territory. While recognizing the deep foundations in the studies of complex behavior, we take ecological structure as the entry point for framework development. This framework is based on a definition of biocomplexity as the degree to which ecological systems comprising biological, social and physical components incorporate spatially explicit heterogeneity, organizational connectivity, and historical contingency through time. These three dimensions of biocomplexity - heterogeneity, connectivity, and history - will be explored as axes of increasing complexity. Basing the description of spatial heterogeneity on either patch or continuous quantification, complexity of spatial structure increases as quantification moves from simple discrimination of patch types and the number of each type to assessment of configuration and the change in the mosaic through time. Organizational complexity reflects the increasing connectivity of the basic units that control system dynamics. At the simple end of the axis, the functional connectivity between units is low, and the processes within a unit are determined by structures or other processes within that unit. At the highest level of complexity along this axis, units in a mosaic interact through fluxes of energy, matter, organisms, or information, and the structure and dynamics of the mosaic can be altered by those fluxes. Temporal relationships in the system range from direct contemporary ones to indirect and historically contingent ones. The influence of indirect effects, legacies, the existence of lagged effects, and the presence of slowly appearing indirect effects constitute increasing temporal complexity. This framework embodies some features of both the structural approach to complexity and the approach of complexity of explanations that we extracted from the literature. It leaves the issue of what levels of each axis result in complex *behavior* as an important question for further research.

Hooper, L. and et al. **Risks and benefits of omega 3 fats for mortality, cardiovascular disease, and cancer: systematic review.** *British Medical Journal* BMJ, doi:10.1136/bmj.38755.366331.2F (published 24 March 2006), 2006.

Notes: Objective To review systematically the evidence for an effect of long chain and shorter chain omega 3 fatty acids on total mortality, cardiovascular events, and cancer. **Data sources** Electronic databases searched to February 2002; authors contacted and bibliographies of randomised controlled trials (RCTs) checked to locate studies. **Review methods** Review of RCTs of omega 3 intake for = 6 months in adults (with or without risk factors for cardiovascular disease) with data on a relevant outcome. Cohort studies that estimated omega 3 intake and related this to clinical outcome during at least 6 months were also included. Application of inclusion criteria, data extraction, and quality assessments were performed independently in duplicate. **Results** Of 15 159 titles and abstracts assessed, 48 RCTs (36 913 participants) and 41 cohort studies were analysed. The trial results were inconsistent. The pooled estimate showed no strong evidence of reduced risk of total mortality (relative risk 0.87, 95% confidence interval 0.73 to 1.03) or combined cardiovascular events (0.95, 0.82 to 1.12) in participants taking additional omega 3 fats. The few studies at low risk of bias were more consistent, but they showed no effect of omega 3 on total mortality (0.98, 0.70 to 1.36) or cardiovascular events (1.09, 0.87 to 1.37). When data from the subgroup of studies of long chain omega 3 fats were analysed separately, total mortality (0.86, 0.70 to 1.04; 138 events) and cardiovascular events (0.93, 0.79 to 1.11) were not clearly reduced. Neither RCTs nor cohort studies suggested increased risk of cancer with a higher intake of omega 3 (trials: 1.07, 0.88 to 1.30; cohort studies: 1.02, 0.87 to 1.19), but clinically important harm could not be excluded. **Conclusion** Long chain and shorter chain omega 3 fats do not have a clear effect on total mortality, combined cardiovascular events, or cancer.

Lesser, M.P. **Oxidative stress in marine environments: Biochemistry and physiological ecology.** *Annual Review of Physiology* 68: 253-278, 2006.

Notes: Oxidative stress -- the production and accumulation of reduced oxygen intermediates such as superoxide radicals, singlet oxygen, hydrogen peroxide, and hydroxyl radicals -- can damage lipids, proteins, and DNA. Many disease processes of clinical interest and the aging process involve oxidative stress in their underlying etiology. The production of reactive oxygen species is also prevalent in the world's oceans, and oxidative stress is an important component of the stress response in marine organisms exposed to a variety of insults as a result of changes in environmental conditions such as thermal stress, exposure to ultraviolet radiation, or exposure to pollution. As in the clinical setting, reactive oxygen species are also important signal transduction molecules and mediators of damage in cellular processes, such as apoptosis and cell necrosis, for marine organisms. This review brings together the voluminous literature on the biochemistry and physiology of oxidative stress from the clinical and plant physiology disciplines with the fast-increasing interest in oxidative stress in marine environments.

Waples, R.S. and Gaggiotti, O. **What is a population? An empirical evaluation of some genetic methods for identifying the number of gene pools and their degree of connectivity.** *Molecular Ecology* 15(6): 1419-1439, 2006.

Notes: We review commonly used population definitions under both the ecological paradigm (which emphasizes demographic cohesion) and the evolutionary paradigm (which emphasizes reproductive cohesion) and find that none are truly operational. We suggest several quantitative criteria that might be used to determine when groups of individuals are different enough to be considered 'populations'. Units for these criteria are migration rate (m) for the ecological paradigm and migrants per generation (Nm) for the evolutionary paradigm. These criteria are then evaluated by applying analytical methods to simulated genetic data for a finite island model. Under the standard parameter set that includes $L = 20$ High mutation (microsatellite-like) loci and samples of $S = 50$ individuals from each of $n = 4$ subpopulations, power to detect departures from panmixia was very high (similar to 100%; $P < 0.001$) even with high gene flow ($Nm = 25$). A new method, comparing the number of correct population assignments with the random expectation, performed as well as a multilocus contingency test and warrants further consideration. Use of Low mutation (allozyme-like) markers reduced power more than did halving S or L . Under the standard parameter set, power to detect restricted gene flow below a certain level X ($H_0: Nm < X$) can also be high, provided that true $Nm \leq 0.5X$. Developing the appropriate test criterion, however, requires assumptions about several key parameters that are difficult to estimate in most natural populations. Methods that cluster individuals without using *a priori* sampling information detected the true number of populations only under conditions of moderate or low gene flow ($Nm \leq 5$), and power dropped sharply with smaller samples of loci and individuals. A simple algorithm based on a multilocus contingency test of allele frequencies in pairs of samples has high power to detect the true number of populations even with $Nm = 25$ but requires more rigorous statistical evaluation. The ecological paradigm remains challenging for evaluations using genetic markers, because the transition from demographic dependence to independence occurs in a region of high migration where genetic methods have relatively little power. Some recent theoretical developments and continued advances in computational power provide hope that this situation may change in the future.

Miner, B.G., Sultan, S.E., Morgan, S.G., Padilla, D.K., and Relyea, R.A. **Ecological consequences of phenotypic plasticity.** *Trends in Ecology and Evolution* 20(12): 685-692, 2005.

Notes: Phenotypic plasticity is widespread in nature, and often involves ecologically relevant behavioral, physiological, morphological and life-historical traits. As a result, plasticity alters numerous interactions between organisms and their abiotic and biotic environments. Although much work on plasticity has focused on its patterns of expression and evolution, researchers are increasingly interested in understanding how plasticity can affect ecological patterns and processes at various levels. Here, we highlight an expanding body of work that examines how plasticity can affect all levels of ecological organization through effects on demographic parameters, direct and indirect species interactions, such as competition, predation, and coexistence, and ultimately carbon and nutrient cycles.

Wikelski, M. and Cooke, S.J. **Conservation physiology.** *Trends in Ecology and Evolution* 21(1): 38-46, 2006.

Notes: Conservation biologists increasingly face the need to provide legislators, courts and conservation managers with data on causal mechanisms underlying conservation problems such as species decline. To develop and monitor solutions, conservation biologists are progressively using more techniques that are physiological. Here, we review the emerging discipline of conservation physiology and suggest that, for conservation strategies to be successful, it is important to understand the physiological responses of organisms to their changed environment. New physiological techniques can enable a rapid assessment of the causes of conservation problems and the consequences of conservation actions.

Svancara, L.K., Brannon, R., Scott, J.M., Groves, C.R., Noss, R.F., and Pressey, R.L. **Policy-driven versus evidence-based conservation: A review of political targets and biological needs.** *BioScience* 55(11): 989-995, 2005.

Notes: "How much is enough?" is a question that conservationists, scientists, and policymakers have struggled with for years in conservation planning. To answer this question, and to ensure the long-term protection of biodiversity, many have sought to establish quantitative targets or goals based on the percentage of area in a country or region that is conserved. In recent years, policy-driven targets have frequently been faulted for their lack of biological foundation. In this manuscript, we reviewed 159 articles reporting or proposing 222 conservation targets and assessed differences between policy-driven and evidence-based approaches. Our findings suggest that the average percentages of area recommended for evidence-based targets were nearly three times as high as those recommended in policy-driven approaches. Implementing a minimalist, policy-driven approach to conservation could result in unanticipated decreases in species numbers and increases in the number of endangered species.

Levin, S.A. **Self-organization and the emergence of complexity in ecological systems.** *BioScience* 55(12): 1075-1079, 2005.

Notes: What explains the remarkable regularities in distribution and abundance of species, in size distributions of organisms, or in patterns of nutrient use? How does the biosphere maintain exactly the right conditions necessary for life as we know it? Gaia theory postulates that the biota regulates conditions at levels it needs for survival, but evolutionary biologists reject this explanation because it lacks a mechanistic basis. Similarly, the notion of self-organized criticality fails to recognize the importance of the heterogeneity and modularity of ecological systems. Ecosystems and the biosphere are complex adaptive systems, in which pattern emerges from, and feeds back to affect, the actions of adaptive individual agents, and in which cooperation and multicellularity can develop and provide the regulation of local environments, and indeed impose regularity at higher levels. The history of the biosphere is a history of coevolution between organisms and their environments, across multiple scales of space, time, and complexity.

Fagan, W.F. and Holmes, E.E. **Quantifying the extinction vortex.** *Ecology Letters* 9(1): 51-60, 2006.

Notes: We developed a database of 10 wild vertebrate populations whose declines to extinction were monitored over at least 12 years. We quantitatively characterized the final declines of these well-monitored populations and tested key theoretical predictions about the process of extinction, obtaining two primary results. First, we found evidence of logarithmic scaling of time-to-extinction as a function of population size for each of the 10 populations. Second, two lines of evidence suggested that these extinction-bound populations collectively exhibited dynamics akin to those theoretically proposed to occur in extinction vortices. Specifically, retrospective analyses suggested that a population size of n individuals within a decade of extinction was somehow less valuable to persistence than the same population size was earlier. Likewise, both year-to-year rates of decline and year-to-year variability increased as the time-to-extinction decreased. Together, these results provide key empirical insights into extinction dynamics, an important topic that has received extensive theoretical attention.

Byrnes, J., Stachowicz, J.J., Hultgren, K.M., Hughes, A.R., Olyarnik, S.V., and Thornber, C.S. **Predator diversity strengthens trophic cascades in kelp forests by modifying herbivore behaviour.** *Ecology Letters* 9(1): 61-71, 2006.

Notes: Although human-mediated extinctions disproportionately affect higher trophic levels, the ecosystem consequences of declining diversity are best known for plants and herbivores. We combined field surveys and experimental manipulations to examine the consequences of changing predator diversity for trophic cascades in kelp forests. In field surveys we found that predator diversity was negatively correlated with herbivore abundance and positively correlated with kelp abundance. To assess whether this relationship was causal, we manipulated predator richness in kelp mesocosms, and found that decreasing predator richness increased herbivore grazing, leading to a decrease in the biomass of the giant kelp *Macrocystis*. The presence of different predators caused different herbivores to alter their behaviour by reducing grazing, such that total grazing was lowest at highest predator diversity. Our results suggest that declining predator diversity can have cascading effects on community structure by reducing the abundance of key habitat-providing species.

Navarrete, S.A. and Berlow, E.L. **Variable interaction strengths stabilize marine community pattern.** *Ecology Letters* 9(5): 526-536, 2006.

Notes: High variability in the strength of species interactions is usually considered a source of unstable or unpredictable community patterns. However, recent theoretical work suggests that some types of variance in interaction strength may actually promote stability. Here we provide the first empirical evidence that highly variable, context-dependent species interaction strengths and resilient community patterns can be two sides of the same coin. Field experiments show that a persistent rocky intertidal seascape is remarkably resilient to multiple sources of environmental stochasticity largely because of scale dependent and variable species interaction strengths. Biological interactions exert a stabilizing effect because their intensity varies systematically with changes in both physical sources of mortality of established species, as well as recruitment of new individuals. Strong variation in species interaction strengths with disturbance size and environmental conditions is ubiquitous in nature. Elucidating when this context dependency will be stabilizing is critical to predict community-level responses to anthropogenic disturbances

Ricketts, T.H. et al. **Pinpointing and preventing imminent extinctions.** *Proceedings of the National Academy of Sciences [USA]* 102(51): 18497-18501, 2005.

Notes: Slowing rates of global biodiversity loss requires preventing species extinctions. Here we pinpoint centers of imminent extinction, where highly threatened species are confined to single sites. Within five globally assessed taxa (i.e., mammals, birds, selected reptiles, amphibians, and conifers), we find 794 such species, three times the number recorded as having gone extinct since 1500. These species occur in 595 sites, concentrated in tropical forests, on islands, and in mountainous areas. Their taxonomic and geographical distribution differs significantly from that of historical extinctions, indicating an expansion of the current extinction episode beyond sensitive species and places toward the planet's most biodiverse mainland regions. Only one-third of the sites are legally protected, and most are surrounded by intense human development. These sites represent clear opportunities for urgent conservation action to prevent species loss.

Hong, S.-H., Bunge, J., Jeon, S.-O., and Epstein, S.S. **Predicting microbial species richness.** *Proceedings of the National Academy of Sciences [USA]* 103(1): 117-122, 2006.

Notes: Microorganisms are spectacularly diverse phylogenetically, but available estimates of their species richness are vague and problematic. For example, for comparable environments, the estimated numbers of species range from a few dozen or hundreds to tens of thousands and even half a million. Such estimates provide no baseline information on either local or global microbial species richness. We argue that this uncertainty is due in large part to the way statistical tools are used, if not indeed misused, in biodiversity research. Here we develop a powerful synthetic statistical approach to quantify biodiversity. It provides statistically sound estimates of microbial richness at any level of taxonomic hierarchy. We apply this approach to a large original 16S rRNA dataset on marine bacterial diversity and show that the number of bacterial species in a sample from marine sediments is $(2.4 \pm 0.5 \text{ SE}) \times 10^3$. We argue that our methodology provides estimates of microbial richness that are reliable and general, have biologically meaningful SEs, and meet other fundamental statistical standards. This approach can be an essential tool in biodiversity research, and the estimates of microbial richness presented here can serve as a baseline in microbial diversity studies.

Earn, D.J.D. and Levin, S.A. **Global asymptotic coherence in discrete dynamical systems.** *Proceedings of the National Academy of Sciences [USA]* 103(11): 3968-3971, 2006.

Notes: Spatial synchrony (coherence) in dynamical systems is of both theoretical and applied importance. We address this problem for a generalization of coupled map lattices (CMLs). In the systems we study, which we term "meta-CMLs," the map at each lattice point may be multidimensional (corresponding, for example, to multispecies ecological systems in which all species have the same dispersal pattern). Most previous work on coherence of CMLs has focused on local stability. Here, we prove a global theorem that provides a useful sufficient condition guaranteeing decay of incoherence in meta-CMLs regardless of initial conditions and regardless of the nature of the attractors of the system. This result facilitates useful analyses of a variety of applied problems, including conservation of endangered species and eradication of pests or infectious diseases.

Cardillo, M., Mace, G.M., Gittleman, J.L., and Purvis, A. **Latent extinction risk and the future battlegrounds of mammal conservation.** *Proceedings of the National Academy of Sciences [USA]* 103(11): 4157-4161, 2006.

Notes: Global conservation prioritization usually emphasizes areas with highest species richness or where many species are thought to be at imminent risk of extinction. However, these strategies may overlook areas where many species have biological traits that make them particularly sensitive to future human impact but are not yet threatened because such impact is currently low. In this article, we identify such areas for the world's mammals using latent extinction risk, the discrepancy between a species' current extinction risk and that predicted from models on the basis of biological traits. Species with positive latent risk are currently less threatened than their biology would suggest, usually because they inhabit regions or habitats still comparatively unmodified by human activity. Using large new geographic, biological, and phylogenetic databases for nearly 4,000 mammal species, we map the global geographic distribution of latent risk to reveal areas where the mammal fauna is still relatively unthreatened but has high inherent sensitivity to disturbance. These hotspots include large areas such as the Nearctic boreal forests and tundra that are unrepresented in most current prioritization schemes, as well as high-biodiversity areas such as the island arc from Indonesia to the south Pacific. Incorporating latent extinction risk patterns into conservation planning could help guard against future biodiversity loss by anticipating and preventing species declines before they begin.

von Krauss, M.K., van Asselt, M.B.A., Henze, M., Ravetz, J., and Beck, M.B. **Uncertainty and precaution in environmental management.** *Water Science and Technology* 52(6): 1-9, 2005.

Notes: In this paper, two different visions of the relationship between science and policy are contrasted with one another: the "modern" vision and the "precautionary" vision. Conditions which must apply in order to invoke the Precautionary Principle are presented, as are some of the main challenges posed by the principle. The following central question remains: If scientific certainty cannot be provided, what may then justify regulatory interventions, and what degree of intervention is justifiable? The notion of "quality of information" is explored, and it is emphasized that there can be no absolute definition of good or bad quality. Collective judgments of quality are only possible through deliberation on the characteristics of the information, and on the relevance of the information to the policy context. Reference to a relative criterion therefore seems inevitable and legal complexities are to be expected. Uncertainty is presented as a multidimensional concept, reaching far beyond the conventional statistical interpretation of the concept. Of critical importance is the development of methods for assessing qualitative categories of uncertainty. Model quality assessment should observe the following rationale: identify a model that is suited to the purpose, yet bears some reasonable resemblance to the "real" phenomena. In this context, "purpose" relates to the policy and societal contexts in which the assessment results are to be used. It is therefore increasingly agreed that judgement of the quality of assessments necessarily involves the participation of non-modellers and nonscientists. A challenging final question is: How to use uncertainty information in policy contexts? More research is required in order to answer this question.

Ravetz, J. **The post-normal sciences of precaution.** *Water Science and Technology* 52(6): 11-17, 2005.

Notes: After centuries of optimism, science has become problematic and compromised. We can no longer assume that innovations are safe until proven dangerous. The 'technocratic' approach to science, with its reductionist methodology and its corporate control, is no longer appropriate. We need a 'precautionary' science that will be 'post-normal' in character. For this, we contrast 'applied science,' like the 'puzzle-solving' of Kuhn's 'normal science' and the 'professional consultancy' like the practice of the surgeon or engineer. Rather, we have a situation where 'facts are uncertain, values in dispute, stakes high, and decisions urgent.' For high-quality decision-making, we need an 'extended peer community' who will bring their 'extended facts' to the dialogue. There are a number of initiatives that advance the post-normal programme, including the endeavours of Foul Harremoes and the conference on Uncertainty and Precaution in Environmental Management.

Gee, D. and von Krauss, M.P.K. **Late lessons from early warnings: towards precaution and realism in research and policy.** *Water Science and Technology* 52(6): 25-34, 2005.

Notes: This paper focuses on the evidentiary aspects of the precautionary principle. Three points are highlighted: (i) the difference between association and causation; (ii) how the strength of scientific evidence can be considered; and (iii) the reasons why regulatory regimes tend to err in the direction of false negatives rather than false positives. The point is made that because obtaining evidence of causation can take many decades of research, the precautionary principle can be invoked to justify action when evidence of causation is not available, but there is good scientific evidence of an association between exposures and impacts. It is argued that the appropriate level of proof is context dependent, as "appropriateness" is based on value judgements about the acceptability of the costs, about the distribution of the costs, and about the consequences of being wrong. A complementary approach to evaluating the strength of scientific evidence is to focus on the level of uncertainty. If decision makers are made aware of the limitations of the knowledge base, they can compensate by adopting measures aimed at providing early warnings of un-anticipated effects and mitigating their impacts. The point is made that it is often disregarded that the Bradford Hill criteria for evaluating evidence are asymmetrical, in that the applicability of a criterion increases the strength of evidence on the presence of an effect, but the inapplicability of a criterion does not increase the strength of evidence on the absence of an effect. The paper discusses the reason why there are so many examples of regulatory "false negatives" as opposed to "false positives". Two main reasons are put forward: (i) the methodological bias within the health and environmental sciences; and (ii) the dominance within decision-making of short term economic and political interests. Sixteen features of methods and culture in the environmental and health sciences are presented. Of these, only three features tend to generate "false positives". It is concluded that although the different features of scientific methods and culture produce robust science, they can lead to poor regulatory decisions on hazard prevention.

van Asselt, M.B.A. and Vos, E. **The precautionary principle in times of intermingled uncertainty and risk: some regulatory complexities.** *Water Science and Technology* 52(6): 35-41, 2005.

Notes: This article explores the use of the precautionary principle in situations of intermingled uncertainty and risk. It analyses how the so-called uncertainty paradox works out by examining the Pfizer case. It reveals regulatory complexities that result from contradictions in precautionary thinking. In conclusion, a plea is made for embedment of uncertainty information, while stressing the need to rethink regulatory reform in the broader sense.

van der Sluijs, J. **Uncertainty as a monster in the science-policy interface: four coping strategies.** *Water Science and Technology* 52(6): 87-92, 2005.

Notes: Using the metaphor of monsters, an analysis is made of the different ways in which the scientific community responds to uncertainties that are hard to tame. A monster is understood as a phenomenon that at the same moment fits into two categories that were considered to be mutually excluding, such as knowledge versus ignorance, objective versus subjective, facts versus values, prediction versus speculation, science versus policy. Four styles of coping with monsters in the science-policy interface can be distinguished with different degrees of tolerance towards the abnormal: monster-exorcism, monster-adaptation, monster-embrace, and monster-assimilation. Each of these responses can be observed in the learning process over the past decades and current practices of coping with uncertainties in the science-policy interface on complex environmental problems. We might see this ongoing learning process of the scientific community of coping with complex systems as a dialectic process where one strategy tends to dominate the field until its limitations and shortcomings are recognized, followed by a rise of one of the other strategies. We now seem to find ourselves in a phase with growing focus on monster assimilation placing uncertainty at the heart of the science-policy and science-society interfaces.