



## BIOdiversity and Economics for CONservation – BIOECON

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*With the contribution of:*



### 15th ANNUAL BIOECON CONFERENCE ON

## “Conservation and Development: Exploring Research and Challenges”

*18-20 September 2013  
Kings College Cambridge, England*

### BOOK OF ABSTRACTS

## Keynote Speech 1

### Red-lists and Hot-spots : Questioning the role of rare species strategies in Biodiversity Management

Thomas Sterner  
Gothenburg University, Sweden

Kerstin Johannesen

There is a broad consensus to protect biodiversity and the primary motivation is to secure life-sustaining systems of the biosphere. However in practice biodiversity is not well defined and many policies are confused. Despite general acknowledgement that ecosystem processes are driven by common species, conservation is in practice focused entirely on rare species through measures like the Endangered Species Act, Red Lists and protection of biodiversity hot-spots. In contrast, management of genetic biodiversity of common species has largely been neglected. There are very many truly rare species: They represent 25-45% of all species, while functionally or numerically dominant species are relatively few in numbers in both species-rich and species-poor ecosystems. Reviewing experimental research on biodiversity and ecosystem function show no evidence that rare species are important to ecosystem structure and function. In contrast, there is growing evidence for the importance of genetic biodiversity at population level, both as a prerequisite for evolutionary modifications in response to environmental changes and as a fundamental component of local adaptation of species. It would thus seem that management activities should be redirected towards functionally dominant species of ecosystems and moved to the level of populations rather than species. Sustaining ecosystem functions will also be beneficial to the rare species, and may be the most cost-effective way to protect them.

## SESSION A1 - Experimental Economics

### The endowment effect and strategic behaviour in repeated procurement auctions: Implications for Payment for Ecosystem Services Schemes

Justin Dijk  
Tillburg University, Netherlands

Daan van Soest

We use an experimental methodology to examine whether bidding behavior in repeated procurement auctions can be explained by a diminishing endowment effect and an increase in strategic behaviour over time. Prospect theory tells us that the loss aversion associated with an endowment leads to asymmetries in valuation and exchange behavior. Experience with market mechanisms reduces the endowment effect (List, 2003), while the likelihood of strategic behavior increases with repetition. We hypothesize that by studying the dynamics of these two effects we can determine an optimal number of rounds (i.e. at least cost for the auctioneer) in repeated procurement auctions. An application can be found in the procurement of agri-environmental benefits.

### Second and Third Party Sanctioning when Monitoring is Costly: Experimental Evidence

Timo Goeschl  
Heidelberg University, Germany

Johannes Jarke

We study monitoring and punishment behavior by second and third parties within a cooperation experiment in which players can decide to resolve imperfect information about the target player's behavior at the cooperation stage, if applicable at a cost. We study how monitoring and punishment respond to changes in information costs, and exploit the evidence gain new insights about the commonalities and differences between second and third party behavior. The key results are the following. First, positive information costs decrease the supply of punishment, and more strongly so in second than in third parties. Second, in the presence of positive information costs a distinct share of subjects switches to «blind» punishment rather than refraining from sanctioning, and this share is larger in third than in second parties. Third, positive information costs lead to defectors making up a smaller share of the punished and receiving smaller punishment compared to zero information costs. Fourth, third party punishment provides increasingly weaker incentives to cooperate relative to second party punishment if monitoring costs increase. Finally, beliefs about the target player's behavior are of minor significance in accounting for the differences between second and third party behavior, suggesting that the kind of social or moral preferences applying in second and third parties, respectively, differ.

## Social effects of Earned vs. Unearned Aid

Andreas Kontoleon  
University of Cambridge, UK

Erwin Bulte, John List, Ty Turley, Maarten Voors

Using a randomized controlled trial in Sierra Leone, we measure the impact of a transfer program aimed at alleviating poverty and reducing pressure on the natural environment. There is limited micro-level empirical evidence on unintended social impacts of aid and, in particular, the differential social effects of conditional versus unconditional aid. We implement three versions of a transfer program in 91 rural communities dependent on slash and burn agriculture. One version provides aid as a gift to the household, one as a gift to the chief to distribute as he sees fit within the community, and one as an aid-for-work program that makes household transfers conditional on supplying labor. We compare outcomes across a range of social and behavioral indicators, including inter-temporal tradeoffs, honesty, social preferences, and civic cohesion. We find no evidence that within village altruism and preferences over honesty are affected by aid. On the other hand giving aid to individuals can reduce conflict in a village and giving aid to the chief for public good provision leads to increased community mobilization. There are surprising negative consequences of making aid conditional—it crowds out personal productivity and participation in public good provision, while raising expectations that unconditional aid is now owed to them.

## The Public Goods Game Revisited

Daan van Soest  
Tillburg University, Netherlands

Jan Stoop, Jana Vyrastekova

Play in standard Public Goods games suggests that on average, humans are quite willing to cooperate in multi-person social dilemmas. Yet cooperation is largely absent in real world social dilemmas where the benefits of cooperation are highest, such as in environmental problems. We hypothesize that this discrepancy is due to the fact that in the Public Goods game the worst free riders can do is to not contribute to the common good, while in most real world environmental situations they can actually undo the good works of others. We construct a modified version of the standard Public Goods game that allows for negative contributions to the common good, and show that average behavior is not statistically different from the Nash equilibrium prediction in any of the periods the game lasts.

## SESSION A2 - Environmental Policy I

### Private Provision of Public Goods under Quantity Regulation: Cap-and-Trade Schemes Limit Green Consumerism

Grischa Perino  
University of Hamburg, Germany

Private provision of public goods can only supplement government provision if individual actions affect the level of the public good. Cap-and-trade schemes reduce the overuse of common resources such as a stable climate or fish stocks by imposing a binding cap on total use by regulated agents. Any private contributions provided by means of e.g. green consumerism or life-style choices within such a scheme only impacts on who uses the resource but leaves total use unaffected. Perfect neutralization of marginal contributions is a key design element of cap-and-trade schemes. The Nash conjecture that contributions by others are given is no longer tenable. As real world cap-and-trade policies like the EU Emission Trading System have incomplete coverage, understanding what they cover is crucial for individuals aiming to contribute. Otherwise contribution efforts backfire.

### Optimal Environmental Taxes and Information Sharing under Private and Public Information Regimes

Jihad El Naboulsi  
Université de Franche-Comté, France

Wassim Daher, Yigit Saglam

In this paper, we present an analysis of how environmental taxes should be optimally levied when the regulator faces incomplete and asymmetric information about production and abatement costs in a Stackelberg-Cournot game. In the first stage, in the presence of costs uncertainties, the regulatory authority sets emissions taxes in order to reduce negative externalities. In the second stage, firms facing asymmetric information compete as Cournot rivals and strategically choose outputs. Firms' marginal production and abatement costs are captured by a linear function defined by the sum of two components: the first component is a public information and the second component is a private information which obeys a linear conditional expectation property. Thus, the realization of a particular firm's cost parameters is a private information to that firm. Consequently, each polluting firm can strategically manipulate both its rival and the regulator's prior cost perceptions. Under this setting, our purpose is to analyze the influence of public and private information on the efficiency in setting environmental taxes. We show that a regulator facing only private information about costs cannot distinguish the two firms and the tax rules are equivalent. In contrast, in the presence of public and private information, the regulator can set firms specific environmental taxes. Then, we examine firms' incentives to share information about firm-specific marginal costs under ex ante environmental regulation through emission taxes. Comparative statics are performed meaningfully in order to analyze changes in environmental taxes in response to changes in the parameters of the model which sometimes are inherently difficult to estimate.

## Fertilizer Taxes for Controlling Agricultural Pollution: An Empirical Assessment

Marita Laukkanen  
Government Institute for Economic Research, Finland

Celine Nauges

Agriculturally produced pollution is a key environmental concern in many European countries. The major policy instrument that is currently in use in the European Union (EU) is national agri-environmental programs (AEP), which provide payments to farmers for reducing the use of agrichemicals. Empirical studies on EU AEPs question the cost-effectiveness of these programs. This paper we considers alternative, price based policies for reducing agriculturally produced pollution, and provides a ranking of an AEP and alternative policy instruments in an empirical setting. The empirical example is based on nutrient pollution from grain production in Finland and voluntary regulation through the Finnish Agri-Environmental Program (FAEP).

## Government Incentives for Private Ownership of Public Goods: Theory and Evidence from Belgium

Joaquin Morales-Belpaire  
University of Namur, Belgium  
Gani Aldashev, François Libois, Astrid Similon

We study the effect of a subsidy to land purchases by NGOs in views of creating natural reserves in the Wallon region of Belgium. A simple theoretical model finds that while the subsidy makes prices soar in the short run, the effect is not persisting in time and prices decline in the long run. We suggest that this happens because the subsidy releases resources for the NGOs that allow them to exert more effort negotiating prices and stimulating supply, effectively driving prices down. We test this prediction empirically benefiting from first-hand collected notarial data and we take advantage of the structural break created by the introduction of the subsidy. Using the MSestimation method (Maronna and Yohai,2000) that is robust to outliers, we provide a methodological contribution in the analysis of markets with quasidonations. The method is relevant for markets of goods with patrimonial value because some sellers are willing (or are persuaded) to donate their assets free of charge for the common good.

## **SESSION A3 - Stated Preference I: Methodology**

### **How Quick can you Click? The Role of Response Time in Online Stated Choice Experiments**

Danny Campbell  
University of Stirling, UK

Morten Raun Morkbak, Soren Boye Olsen

In this paper we utilise paradata relating to the response latency as a measure of the cognitive effort invested by respondents in self-administered online stated preference surveys. While the effects of response latency have been previously explored, this paper proposes a different approach. Specifically, we compare scale-adjusted latent class models based on preference homogeneity to those that facilitate preference heterogeneity and make further comparisons based on whether the influence of response latency is assumed to be deterministic or probabilistic. To test our methodology we use stated choice data collected via an online survey to establish German anglers' preferences for fishing site attributes in Denmark. Results from our analysis reinforce that response latency has a bearing on the estimates of error variance and the utility coefficients. Importantly, our latent class models also show that, irrespective of the length of time respondents take to complete the choice experiment, there is always a subset with high error variance (i.e., more randomness), but that this decreases as response latency increases. While estimates of willingness to pay are not affected, we observe that the manner in which response latency is accommodated has implications on the predictions of fishing trips and expected revenue.

### **Protest Attitudes and Stated Preferences: Evidence on Scale Usage Heterogeneity**

Vladimir Otrachshenko  
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Maria Cunha-e-Sa, Luis C. Nunes

We contribute to the stated preference literature by addressing scale usage heterogeneity regarding how individuals answer attitudinal questions capturing lack of trust in institutions and fairness issues. Using a latent class model, we conduct a contingent valuation study to elicit the willingness-to-pay to preserve a recreational site. We find evidence that respondents within the same class, that is, with similar preferences and attitudes, interpret the Likert scale differently when answering the attitudinal questions. We identify different patterns of scale usage heterogeneity within and across classes and associate them with individual characteristics. Our approach contributes to a better understanding of individual behavior in the presence of protest attitudes.

## Testing Embedding or Reversed Embedding Effects in Valuation of Forest Biodiversity

Fatemeh Bakhtiari  
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Thomas Hedemark Lundhede, James Gibbons, Niels Strange, Jette Bredahl Jacobsen

Embedding effects play a crucial role in the validity of stated preference outcomes, often arising from imprecise categorization of goods such as biodiversity. In this study, two aspects of embedding are addressed, contextual embedding and scope sensitivity in biodiversity valuation. While the latter is frequently tested for in choice experiments (CE), the former is not. Qualitative evidence shows that people tend to think of biodiversity in terms of its functionality such as stability and resilience. Yet, many studies focus solely on quantitative measures of biodiversity such as the number of species. This may induce a reversed embedding effect. We report a split sample of a CE study, in which willingness to pay (WTP) for biodiversity was evaluated in two different embedding contexts: one version where biodiversity was presented as the number of species and one version where we also included an attribute, fully correlated with the biodiversity attribute, describing the functionality of biodiversity. We found WTP for biodiversity to differ significantly between the two versions and thus conclude that using common measures like the number of species may underestimate people's value of biodiversity. Additionally we found that adding a description of the functionality of biodiversity explicitly in the choice set improved scope sensitivity, not only for the attribute in hand but also for a related attribute. Consequently, the present study shows that contextual embedding which may also influence scope sensitivity. Embedding effects and scope sensitivity are not intrinsic to the choice experiment method but arise from how biodiversity is presented. By presenting attributes directly related to public mental constructs of biodiversity we argue that more reliable value estimates can be obtained.

## Public Support for Conserving Bird Species Runs Counter to Climate Change Impacts on their Distributions

Bo Jellesmark Thorsen  
University of Copenhagen, Denmark

Nick Hanley, Thomas Hedemark Lundhede, Jette Bredahl Jacobsen, Jon Fjeldsa, Carsten Rahbek, Niels Strange

Studies have documented the publics' willingness to pay for protecting biodiversity, particularly native species. However, there is increasing evidence that climate change significantly change the spatiotemporal occurrences of many species. Using realistic scenarios of climate change impacts on birds and their conservation value at European level, we investigate the willingness to pay of the general public in Denmark for the preservation of climate-induced immigrating breeding birds as well as for native breeding birds. The public is willing to pay more for preserving native bird species, than for immigrating species - even if both are under pressure from climate change. For immigrating species willingness to pay is highest for low population levels, whereas for native species it is highest for high levels. The results elucidate that popular support for conservation is at odds with likely climate change impacts, and may challenge global geopolitical coordination of biodiversity conservation.

## **SESSION A4 - Special Session: Climate Change Adaptation**

### **Explaining Investment in Soil Conservation: Weather Risk, Rate of Time Preferences and Tenure Security in the Highlands of Ethiopia**

Mintewab Bezabih

London School of Economics, UK

Salvatore di Falco, Gunnar Kohlin

This paper investigates the role of weather risk, rate of time preferences and tenure security on the implementation of soil conservation strategies in rural Ethiopia. To this end we combine farm household level panel data, farm specific weather data, and subjective rate of time preferences measured using a hypothetical experiment. We find that weather risk plays an important role in increasing the rate of time preferences, reducing the propensity to invest in soil conservation. In addition, increased tenure security, in the form of land certificate holding, is shown to significantly increase investment in soil conservation. Although we find evidence that RTP, driven up by weather risk, dampen the incentive to invest in soil conservation, this inclination is dramatically reduced for households with higher tenure security. Our findings imply that increased weather variability under climate change could have devastating implications in terms of increased land degradation due to reduced investments in soil conservation and the resulting poverty trap for the people. However, it also points to the potential of adding tenure reform to the increasing number of climate change adaptation measures.

### **Managing Environmental Risk in the Presence of Climate Change: The Role of Adaptation in the Nile Basin of Ethiopia**

Salvatore di Falco

University of Geneva, Switzerland

Marcella Veronesi

This study investigates the impact of climate change adaptation on farm households' downside risk exposure in the Nile Basin of Ethiopia. The analysis relies on a moment-based specification of the stochastic production function. We use an empirical strategy that accounts for the heterogeneity in the decision on whether to adapt or not, and for unobservable characteristics of farmers and their farm. We find that past adaptation to climate change (i) reduces current downside risk exposure, and so the risk of crop failure; (ii) would have been more beneficial to the non-adapters if they adapted, in terms of reduction in downside risk exposure; and (iii) is a successful risk management strategy that makes the adapters' more resilient to climatic conditions.

## Adaptation to Climate Change: The Role of Irrigation

Martina Bozzola

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This paper investigates the effect of irrigation as a tool to adapt to climate uncertainty in agriculture. Our model relies on a moment based approach to investigate how individual producers' optimize input usage, taking into account their risk preferences. Agents optimize in an environment characterized by regulatory constraints in water stock's access. We derive the risk preference of a population of Italian farmers across Italy for two years and find difference in risk preference parameters. We propose significant extensions to fully exploit the panel dimension of the data set.

## Climate Change and Adaptation: The Case of Nigerian Agriculture

Francesco Bosello

Fondazione Eni Enrico Mattei, Italy

Lorenza Campagnolo, Fabio Eboli

The present research offers an economic assessment of climate change impacts on the four major crop families characterizing Nigerian agriculture, covering more than 80% of agricultural value added. The evaluation is performed shocking land productivity in a computable general equilibrium model tailored to replicate Nigerian economic development until the mid of this century. The detail of land uses in the model has been also increased differentiating land types per agro ecological zones. Uncertainty on future climate is captured, using, as input, yield changes computed by a crop model, covering the whole range of variability produced by an envelope of one RCM and ten GCM runs. Climate change turns to be unambiguously negative for Nigeria in the medium term with production losses, increase in crop prices, higher food dependency on foreign imports and GDP losses in all the simulations after 2025. In a second part of the paper a cost effectiveness analysis of adaptation in Nigeria agriculture is conducted. Adaptation practices considered are a mix of cheaper "soft measures" and more costly "hard" irrigation expansion. The main result is that cost effectiveness of the whole package crucially depends on the possibility to implement adaptation exploiting low cost opportunities. In this case all climate change damages can be offset with a benefit cost ratio larger than one in all the climate regimes. Expensive irrigation expansion should however be applied on a much more limited acreage compared with soft measures. If adaptation costs are those of the high end estimates, full adaptation ceases to be cost/effective. This points out the need of a careful planning and implementation of adaptation, irrespectively on the type, looking for measures apt to control its unit cost.

## **SESSION B1 – Agriculture I: Technology, Biodiversity and Food Security**

### **Understanding the Impact of Agricultural Technology Adoption: *K*-Factors, Spillovers and Pitfalls**

Ben Groom  
London School of Economics, UK

Aliou Diagne

This paper sheds light on estimating the impact of the adoption of agricultural technology. Where modern crop varieties are the technology the Average Treatment Effect on yield associated with a binary adoption indicator is shown to comprise of adoption intensity, the ‘innovation effect’ or ‘*k*-factor’ and an in-farm spillover effect of adoption on traditional varieties. Hence, ATE may be zero in the presence of large *k*-factors or positive in the absence of such an innovation effect due to spillovers. Methods are developed to empirically identify these individual components and the nature of impact is shown to be heterogeneous across several Sub-Saharan countries. A potential pitfall is highlighted when adoption is defined as the continuous proportion of land in modern varieties. The Average Partial Derivative in such a case will be zero if farmers are profit maximising, and measure any number of deviations from profit maximisation otherwise.

### **Tenure Insecurity and Investment in Soil Conservation. Evidence from Malawi**

Stefania Lovo  
London School of Economics, UK

Tenure insecurity can have important consequences for the conservation of natural resources. Land titling is often considered a solution to the problem of weak investment incentives. Using a large plot-level dataset from Malawi, this paper shows that land titling alone might not induce greater investment in soil conservation under the existing customary inheritance systems and that a reform of the rental market is in order. The paper focuses on two main sources of tenure insecurity: informal short-term tenancy contracts and customary gender-biased inheritance practices. Both sources of insecurity matter for soil conservation investments and are likely to be unaffected by the introduction of land titling alone. Further evidence suggests that soil erosion can have adverse distributional effects and that tenure insecurity accounts for one-third of the long-term loss in land productivity.

## The Impact of Biodiversity on Child Health: Empirical Evidence from South Africa

Marcella Veronesi  
ETH Zurich, Switzerland

Jonas Hilty

Child undernutrition is widespread in developing countries and has long lasting negative consequences on economic development. Recently, the promotion of agricultural biodiversity has been suggested as an additional means to improve nutrition and health. However, no empirical evidence currently exists on whether biodiversity improves health. We use panel data from KwaZulu-Natal, South Africa to investigate the effect of crop biodiversity on child health. Using a dynamic panel model we estimate the effect of crop biodiversity on child growth and control for unobserved heterogeneity. We show that crop biodiversity has a positive and significant impact on long term child nutritional status. An increase in crop biodiversity has a positive and significant effect on children's height, while it has no effect on weight, and BMI.

## SESSION B2 - Fisheries I: Invasive Species

### Fishy Fish: The Economic Impacts of Escaped Farm Fish

Yajie Liu  
SINTEF, Norway

Jon-Olaf Olausen, Anders Skonhoft

The escape of cultured fish from a marine aquaculture facility is a type of biological invasion that may lead to a variety of potential ecological and economic effects on native fish. This paper develops a general invasive species impact model to capture explicitly both the ecological and economic effects of invasive species, especially escaped farmed fish, on native populations and harvests. First, the possible effects of escaped farmed fish on the growth and stock size of a native fish are examined. Next, a bioeconomic model to analyze changes in yield, benefit distribution, and overall profitability is constructed. Different harvesting scenarios, such as commercial, recreational, and joint commercial and recreational fishing are explored. The model is illustrated by a case study of the interaction between native and farmed Atlantic salmon in Norway. The results suggest that both the harvest and profitability of a native fish stock may decline after an invasion, but the total profits from the harvest of both native and farmed stocks may increase or decrease, depending on the strength of the ecological and economic parameters.

### Wild Salmon Harvest with Farmed Salmon Induced Mortality

Jon-Olaf Olausen  
Trondheim Business School, Norway

Yajie Liu, Anders Skonhoft

Recently, increased sea lice densities caused by salmon farming have received growing attention in the main producer countries Canada, Chile and Norway. This paper presents a bioeconomic model for wild Atlantic salmon on the basis of the actual sea lice problem in Norway and explores the extent to which the optimal harvest pattern is affected by sea lice induced mortality. Because the salmon post smolts are the most vulnerable to attack by salmon sea lice, while harvest value is related to the mature spawning fish, an age structured population model is required. The economic losses are analyzed by calculating the reduced harvesting value of the mature salmon due to various sea lice induced mortality scenarios. We compare the situation in which the harvest activity is assumed *not* to be influenced by sea lice with the case where the manager maximizes the sustainable harvesting value taking sea lice induced mortality into account.

## Sustainability Harvest of a Native Species and Control of an Invasive Species: A Bioeconomic Model of a Commercial Fishery Invaded by a Space Competitor

Marjolaine Fresard  
University of Brest, France

Carole Ropars-Collet

Biological invasions are nowadays an important challenge to biodiversity and human welfare. This paper deals with the control of an invasive species, void of market value, and acting as a space competitor for a valuable native harvested species. It presents a theoretical bioeconomic model describing the interacting dynamics of the two species and accounting for the undesirable consequences of native stock harvesters' behaviour on the spread of invasion. Dynamic optimisation of the model displays the existence of a time-path leading to an optimal stationary steady-state solution where the native species is sustainably harvested and the invasive species is kept under control, provided unit costs of native species harvesting and of invaded areas cleaning are quite low, natural and anthropogenic dispersal coefficients of invasion, and time-discount rate are moderate. Moreover, the problem should be addressed early enough

## SESSION B3 - Natural Resource Management: Wildlife and Nuisance Species

### An Institutional Perspective on Externalities. The Nordic Wolf re-colonisation

Jan Tore Solstad  
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Eivind Egeland Aronsen, Anders Skonhoft

The paper discusses and redefines the traditional concept of externalities. Inspired by J.R. Commons' theory of institutional evolution we define externalities as policy relevant institutional interdependencies. Our concept of externalities is more general and reflects institutional failure rather than market failure. We exemplify our institutional concept of externalities by discussing the conflicts associated with the re-colonization of wolves in Scandinavia. Pinpointing the conflict between wolf management and sheep farming, we identify externalities in the *de jure* property rights to the pastures: As the wolf is supposed to live in multi-use landscapes, the grazing right of the sheep farmers and the public right to have a viable wolf population are mutually exclusive. Compensation payments for sheep killed by wolves only redistribute benefits and costs between the sheep farmers and the wildlife authorities (representing society at large), and do not reduce the conflict. One way to eliminate the externalities is to clarify the *de jure* property rights and separate sheep and wolves.

### Optimal Species Preservation Policy in Symbiotic Relationships between Species

Mordechai Shechter  
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Shiri Zemah Shamir, Benyamin Shitovitz

In recent years, economists and ecologists have become increasingly interested in optimal conservation policies to protect natural areas and the biodiversity embodied in them. A famous metaphor that describes this conservation policy is the Noah's Ark problem: Noah had to decide which species he should take aboard the ark to survive, and which were to become extinct (Weitzman, 1998). One of Weitzman's conclusions is that the optimal policy is an extreme policy. Thus, in the Noah's Ark model, almost all species go aboard either in full or not at all. In the case of a symbiotic relationship, the classic optimal policy of Noah's Ark problem might not stand. We examine optimal preservation policies in different costs functions and obtain a ranking criterion based on cost-effectiveness analysis.

## Conservation versus Exploitation of Wild Animal Species: Property Rights and Conflicts

Anne Borge Johannesen  
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Anders Skonhoft

This paper formulates a bio-economic model to analyze the conservation and development effects of various benefit-sharing programs where income from tourism in a protected area is transferred to local communities. The paper focuses on the strategic interaction between the protected area manager and the local people. The park manager benefits from wildlife through tourism and hunting, and invests in anti-poaching law enforcement. The local people benefit through illegal hunting and also bear cost from wildlife induce damage. The paper distinguish between two types of benefit-sharing: i) indirect money transfers from park tourism to the local people, where transfers are made independently of whether the local people hunt illegally, and ii) direct money transfers where payments are made only if illegal hunting is not detected. Making transfers conditional on illegal hunting is in accordance with recommendations made by, e.g., Ferraro (2001), who stress the need to make incentives conditional on the conservation target as opposed to indirect transfers. This paper demonstrates that direct transfers may or may not promote wildlife conservation. In addition, the welfare effect is unclear.

## **SESSION B4 - Payments for Ecosystem Services**

### **Private Forest Owners' Willingness to Accept Contracts for Ecosystem Service Provision**

Suzanne Vedel  
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Jette Bredahl Jacobsen, Bo Jellesmark Thorsen

Provision of ecosystem services from Danish forests relies to a great extent on voluntary engagement by forest owners. This can be through voluntary participation in environmental contracts promoting ecosystem services or forest owners' own initiatives. Another way is through changes in the legal setting demanding specific changes on private land, with or without compensation, such as Natura2000 policies.

We have investigated Danish forest owners' preferences for voluntary participation in the provision of specific ecosystem services closely related to the contemporary Natura2000 framework. This involves leaving old trees for natural aging and decay, setting aside untouched forest areas, accepting a fixed percentage of broadleaves in the forest and increased access on foot for the public. The study adds a new element to the literature by investigating the link between current forest management on individual properties and the WTA for ecosystem services. Analyses based on a Choice Experiment show, that among the investigated attributes, granting the public increased rights of access is by far the most expensive element; the average respondent requires 121 DKK/ha and year for accepting access up to 15 meters from roads and paths and 242 DKK/ha and year for accepting access everywhere in forest. Forest owners also require compensation for leaving untouched forest areas (3.6 DKK/ha and year for 1% of their forest area). Accepting a broadleaves restriction only involves compensation when it is on 75% of the forest area (53 DKK/ha and year), whereas they do not require compensation for the lower levels investigated here (25%, 50%). Preserving dead trees stands out as the attribute respondents are willing to accept the lowest amount of compensation for - if they already do this on their property (approximately -75 DKK/ha and year for preserving 5 trees). Results also show that forest owners' attitude towards their role as 'ecosystem service providers' for the community has a significant effect on their compensation requirements for increased access. Respondents who find it important that subsidy schemes are beneficial for the local community require approximately 81 DKK/ha and year less in compensation for providing access up to 15 meter from roads and paths. As opposed to this, respondents who use the forest for hunting require approximately 47 DKK/ha and year additional to the 121 DKK/ha and year for granting access up to 15 meters from roads and paths. Policy-wise, these analyses add information regarding to which extent we can expect forest owners to provide some of these ecosystem services voluntarily and without compensation. Moreover, it also points out which types of services draw more heavily on both the good-will, alignment with personal interests and the compensation requirements, when forest owners take on the role as providers of these ecosystem services.

## Material Transfer Agreements: An Economic and Econometric Analysis

Laura Onofri  
The Mediterranean Science Commission, Monaco

This paper uses econometric analysis for understanding the determinants that affect the payment mechanism in material transfer agreements (MTAs). These contracts regulate the exchange of peculiar ecosystem services (genetic and biological material) between a provider and a recipient of the service. The paper uses a set of “model” contracts from the late 2000s, gathered from the U.N. World Intellectual Property Organization (WIPO) and the Convention of Biological Diversity (CBD). We use a probit model with endogenous regressors in order to test the probability that a MTA prescribes for a payment (and or other monetary/non monetary benefits) and the variables that positively/negatively affect that probability. Empirical results show that the probability that a payment scheme is included in the contract negatively depends on the presence of an acknowledgement obligation to the provider of the material. Probably aware of the complexity and uncertainty of the recipient’s research activity, the provider (and the CBD) requires to be compensated through the recognition of his/her important input to the research venture. In economics, this can be interpreted as payment in terms of moral satisfaction.

## Do Communication and Distributional Issues Affect PES Effectiveness? Insights from a field experiment in Peru

Estelle Midler  
Basque Centre for Climate Change, Spain

Adam Drucker, Ulf Narloch, Unai Pascual, Jose Luis Soto

How should PES be designed to protect the environment effectively? In this paper we investigate i) How the way a payment for agrobiodiversity conservation is shared within a community impacts subjects behavior and therefore its effectiveness ii) what would be the impact of communication on egalitarian rewards effectiveness? Results show that proportional rewards are more cost-effective than egalitarian ones. We also show that egalitarian rewards perform better if communication is allowed. Finally we analyzed how both types of reward and communication interact with farmers’ social preferences and found that the egalitarian reward creates reciprocity by triggering guilt feeling while the proportional reward slightly crowds-out intrinsic motivation. Also, the egalitarian reward effectiveness might depend on the level of trust within the environment.

## SESSION C1 - Fisheries II

### Exploring the Influence of Fisheries Management Regimes and Value Chain on Price Formation at Auction: The Case of French Scallop Fisheries

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Gabrielle Lesur-Irichabeau, O.Guyader

In a context of the internationalisation of markets, a key issue to consider when analyzing public policies is the interactions that exist between fishery management regimes and economic performance of fishery supply chains, from fishing fleets to consumers. The scallop fisheries are among the most important fisheries in France, and the French market is one of the principal scallop markets at international level. Most of these fisheries are regulated through licencing systems, with limitations on fishing effort limiting (rationing) fishermen's landings, and hence limiting supply in turn to auction markets. The management system has also brought some changes on the side of demand concerning first level purchasers (fishmongers, wholesalers, processors, ...). The objective of the proposed paper is to study the influence of fisheries management on price formation at auction market, with application to the French small-scale scallop fisheries. An econometric model is constructed using an annual data set including all daily scallop auction transactions between fishermen and first purchasers in different auction locations. A large set of potential explanatory variables are tested, including the supply and characteristics of products deriving from the individual fisheries, but also the characteristics of the suppliers/purchasers. Specific relationships such as habits between operators are explored. The results are analyzed and discussed regarding expected future changes in scallop fishery regulations.

### Robust Viable Management of a Harvested Ecosystem Model

Esther Regnier  
Paris School of Economics, France

Michel de Lara

The World Summit on Sustainable Development (Johannesburg, 2002) encouraged the application of the ecosystem approach by 2010. In this perspective, we propose a theoretical management framework that deals jointly with i) ecosystem dynamics, ii) conflicting issues of production and preservation and iii) robustness with respect to dynamics uncertainties. More specifically, we define the robust viability kernel as the set of initial species biomasses such that at least one harvesting strategy guarantees minimal production and preservation levels for all times, whatever the uncertainties. We apply our approach to the anchovy-hake couple in the Peruvian upwelling ecosystem. We find that accounting for uncertainty significantly reduces the robust viability kernel compared to the deterministic one (without uncertainties). We observe that, when we increase the set of uncertainties, the robust viability kernel very slightly decreases, expressing a moderate sensibility with respect to refining the set of uncertainties. We comment on the management implications of comparing robust viability kernels (with uncertainties) and the deterministic one (without uncertainties).

## Bioeconomic Factors of Natural Resource Transitions: The US Sperm Whale Fishery of the 19<sup>th</sup> Century

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This paper uses bio-economic modelling to investigate the transition from whale oil (a renewable, exhaustible natural resource) to petroleum that occurred in the mid-19th century. The discovery of petroleum is often presented as a stochastic event that 'saved the whales'; we combine newer biological evidence (Whitehead 2002) with economic theory of natural resources and uncertainty to address this long-standing controversy over whether sperm whale fishery dynamics would have been sufficient to preserve the sperm whale population without the discovery of petroleum (e.g. Davis et al, 1988; Maran 1974; Shuster 1973). We find that under most economic conditions the dynamics, even without a substitute, would have prevented extinction but not depletion; this result is different than that usually determined for the better studied baleen whales, due in part to biological differences and in part to differences in their economic productivity as harvested resources. The paper is part of a larger project investigating the timing of resource transitions and how the increasing costs and demand for illuminants drove the search for substitutes and how successful drilling for petroleum presented the best substitute from an array of interdependently developing resources and technologies, cementing the decline of the US sperm whaling industry.

## **SESSION C2 - Economics of Ecosystem Services I**

### **Urban Ecosystem Services and Human Well-Being: The Role of Urban Green Spaces**

Christine Bertram  
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Katrin Rehdanz

Urban green spaces provide numerous ecosystem services (ES) for city inhabitants. Besides provisioning and regulating services, they also provide cultural services by giving people the possibility to recreate and experience nature in the city. In this paper, we elicit the value of urban green spaces for human well-being using the life satisfaction approach (LSA). We use self-reported information on life satisfaction as a proxy for well-being to investigate the influence of urban green space on the life satisfaction of the residents of Berlin, the capital city of Germany. In a second step, we use the implicit marginal rates of substitution (MRS) to calculate the willingness-to-pay (WTP) that people have for urban green spaces. We find a statistically significantly positive effect of urban green space on people's life satisfaction. Moreover, our results support psychological findings that not only potential access to green space but also passive views onto parks increase people's well-being.

### **Managing Multiple Ecosystem Services Provision: Cereal Production, Soil Quality and Habitat Preservation**

Rui Mota  
NOVA School of Business and Economics, Portugal

Maria A. Cunha-e-Sa

We develop a model for the optimal management of multiple ecosystem services provision, namely, of cereal production, soil quality and habitat preservation for an endangered species (in general, biodiversity preservation) in a cereal steppe area. When ecosystem services are jointly produced, paying for only one service may be detrimental to the whole system. The interactions between these three ecosystem services provide interesting insights, given the presence of tradeoffs. As land is privately owned there is scope for intervention. We compare the social planner's solution with the regulated one. While private landowners do not internalize the habitat preservation yet they take into account the effect of their decisions on soil quality. Thus, we identify the optimal mix of instruments (taxes and subsidies) required to implement the social optimum. We show that only one instrument is not enough (as it is currently applied in the case study area). We derive the optimal policy instruments at the optimum, as well as along the optimal path. Policy implications are derived

## Assessing Trade-Offs between Food Production, Biodiversity and Carbon Sequestration for Eastern Europe

Arjan Ruijs

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Ada Wossink, Mika Kortelainen

Understanding the trade-offs between food production, biodiversity, carbon sequestration and other ecosystem services has become increasingly important for local, national and global policy making. This paper contributes to this understanding by developing and demonstrating a method by which the spatially explicit opportunity costs of several jointly produced ecosystem services can be estimated. The method is based on a two-stage frontier approach using parametric and non-parametric estimation techniques. The approach is implemented with ecosystem services data for 18 Central and Eastern European countries. Results show that opportunity costs of changes in biodiversity and carbon sequestration differ substantially between regions. Those areas having already relatively high levels of carbon sequestration have a comparative advantage in sequestering more carbon. Opportunity costs of biodiversity generally increase with increasing biodiversity up to a turning point after which they decrease. We argue that the method and resulting opportunity costs can lead to more integrated and rigorous policy support and dialogue.

## **SESSION C3 - Fisheries III: Management under Uncertainty**

### **Habitat Fisheries Interactions and Management: The Case of Redfish Fisheries and Cold Water Coral in Iceland**

Claire Armstrong  
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Naomi Foley, Viktoria Kahui

Developing a bioeconomic model of fisheries and habitat applying open access and optimal management, this paper shows that the societal importance of fish habitat depends in part on the management of the fishery. The loss of habitat has a greater relative effect on harvests in an optimally managed fishery compared to that of open access. However, the model suggests that when a fishery is low cost, a loss of habitat will result in greater absolute declines in harvests in the optimally managed fishery while if the fishery is high cost the absolute decline in harvest is greater in the open access fishery. Using time series data for Icelandic redfish fisheries and estimates of possible outer limits of cold water coral decline, a habitat often linked to redfish, the model is empirically tested. The results show indications of economic losses in the fishery due to cold water coral decline. Moving from a low habitat decline to a high one, the Icelandic fishery moves from being low cost to high cost. The results of this study illustrate how habitat loss may affect fisheries, and underline the importance of taking into account the broader fisheries externalities of habitat destruction when optimally managing the fishery itself.

### **Stochastic Ecoviability for Small Case Fisheries**

Luc Doyen  
National Centre for Scientific Research, France

A.A. Cissé, F. Blanchard, JC Pereau

This paper offers a theoretical and empirical model of ecosystem-based fishery management. A multi-species and multi-fleet model integrating stochastic Lotka-Volterra trophic dynamics as well as production and profit assessments is developed and applied to the coastal fishery of French Guiana. This small-scale fishery constitutes a challenging example with high fish biodiversity, several non selective fleets and a potentially increasing local food demand due to demographic growth. The dynamic bio-economic model is calibrated with thirteen species and four fleets using monthly catch and effort data from 2006 to 2010. Several contrasted fishing scenarios including status quo, total closure, economic and viable strategies are then simulated. They are compared in risk terms from the viewpoints of both biodiversity conservation and socio-economic performances. We show to what extent fishing outputs, including food supply and fleet profitability, can be sustained with a high probability but a loss of biodiversity cannot be avoided.

## Risk vs Economic Performance in a Mixed Fishery: the Case of the Northern Prawn Fishery in Australia

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O. Thébaud, C. Dichmont, S. Jennings, L.R. Little, S. Pascoe, R.A. Deng, L. Doyen

Balancing bio-economic risks and high profit expectations is often a major concern in fisheries management. We examine this trade-off in the context of the Australian Northern Prawn Fishery (NPF), which is managed to achieve Maximum Economic Yield (MEY). The fishery derives its revenue from different prawn species with more or less uncertain dynamics and recruitment. A multispecies bio-economic and stochastic model is used to examine the trade-offs between mean economic performance of the fishery and the variance of this performance, under a range of economic scenarios and strategies with respect to fleet capacity and effort allocation. Simulation results show that the observed fishing strategy displayed by the fleet might be interpreted as seeking the best compromise between performance and risk. Increases in fleet size or in the annual fishing effort of vessels would only improve the expected economic performance of the fishery at the cost of increased variability of this performance. Under a likely economic scenario, adaptation of the fishery to maintain current levels of economic performance is likely to depend on the extent to which operators in the fishery are willing to accept higher levels of economic risk.

## SESSION C4 - Common Property Resources: Norms and Property Rights

### Partial Enclosure of the Commons

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Christopher Costello, Agnes Tomini

We examine the efficiency, distributional, and environmental consequences of assigning spatial property rights to part of a spatially-connected natural resource, a situation which we refer to as partial enclosure of the commons. The model reflects on a large class of institutions and natural resources for which complete enclosure by a sole owner may be desirable, but is often institutionally impractical. When a sole owner is granted ownership of only a fraction of the spatial domain of the resource and the remainder of the resource is competed for by an open access fringe, interesting spatial externalities arise. We obtain sharp analytical results regarding partial enclosure of the commons including: (1) While second best, it always improves welfare relative to no property rights, (2) all resource users are made better off, (3) positive rents arise in the open access area, and the resource will maintain higher abundance. Under spatial heterogeneity, we also characterize spatial regions that are ideal candidates for partial enclosure - typically, society should seek to enclose those patches with high ecological productivity and high self-retention, but whether high economic parameters promote or relegate a patch may depend on one's objective. These results help inform a burgeoning trend around the world to partially enclose the commons.

### Using Economic Information to Anticipate Transitions in Social-Ecological Systems

Andries Richter

CEES, University of Oslo, France

Vasilis Dakos

A common pattern of environmental crises is a vicious cycle between environmental degradation and socio-economic disturbances. For example, environmental changes may drive fish stocks to a low productive regime that can lead to sudden losses in the livelihoods of coastal communities. This ecological transition in turn erodes social institutions, such as social norms of cooperation, with cascading pressure on the resource base. Here we show that while such feedbacks may give rise to critical transitions in social-ecological systems, at the same time they can offer novel opportunities for anticipating them. We model a community that has joint access to the harvest grounds of a resource that is prone to collapse. Individuals are tempted to overexploit the resource, while a cooperative harvesting norm spreads through the community via interpersonal relations. Both social and ecological collapses can be induced by environmental and socio-economic driving forces. Regardless of the type and cause of collapse we find that upcoming transitions may be detected using simple socio-economic response variables, such as individual profits. At the same time, adaptive behaviour of resource users may mask signs of a nearby resource collapse. Our findings suggest that social-ecological systems not only hide vulnerabilities to collapse as changes spread from one system to the other, but that they may also provide alternative sources of information that can be used to detect up-coming critical transitions.

## Why are Some Communities Able to Preserve Their Natural Resources when Others Fail to Achieve It?

François Libois

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This paper presents an analytical framework to understand why some communities successfully manage their renewable natural resources and some fail to do it. We develop a two players, two-period non-cooperative game where a community can impose some exogenous amount of sanctions. We show that rules preventing dynamic inefficiencies may exist even though static inefficiencies still remain. Inequalities reduce static inefficiencies but increase dynamic inefficiencies.

## **SESSION D1 - Stated Preference: Applications**

### **Investigating Fishers' Preferences for the Design of Marine Payments for Environmental Services Schemes: The Application of Choice Experiments**

Rhona Barr  
Conservation Strategy Fund, UK

Suzanna Mourato

We determine the effects of various management restrictions on adoption rates of marine PES schemes. Choice experiments are used in order to determine how fisher participation rates change under different marine PES programme designs. Various designs, with differing restriction rates, show different rates of adoption. However, fishers show a high utility loss associated with any move away from the current management situation, irrespective of restriction levels. This indicates that PES scheme costs may be high and creating an enabling environment could be important to reducing these perceived losses, as could investment into conditional in-kind compensation mechanisms. The paper also shows choice experiments to be a useful tool in marine PES design.

### **Non-Market Use and Non-Use Values for preserving Ecosystem Services over time: A Choice Experiment application to Marine Ecosystems in New-Caledonia**

Jean Baptiste Marre  
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Luke Brander, Olivier Thebaud, Sean Pascoe, Nicolas Pascal, Jean Boncoeur, Louisa Coglan

Non-use values are probably some of the most compelling reasons for Ecosystem Goods and Services (EGS) preservation (Chan et al., 2012). Nevertheless, there still exist challenges to their precise characterization and quantitative estimation, especially when it comes to EGS economic valuation and when the willingness-to-pay estimation exercise focuses on EGS users. We tackle this issue by: (1) reviewing briefly the literature about non-use values in EGS economic valuation; (2) offering a pragmatic economic interpretation of non-use values through EGS preservation over time, which allows estimating them individually for users in addition to and separately from non-market use values; (3) applying empirically our approach with a choice experiments case study in New-Caledonia in two coral reef coastal areas with different institutional, cultural, environmental and socio-economic contexts (4) discuss critically our methodology and the results we obtained, notably non-linear part worth utilities functions and a significant cost attribute non-attendance, in view of supporting decision-making.

## Price Effects and the Demand for Illegally-hunted Bushmeat in the Serengeti: An Investigation using a Choice Experiment

Nick Hanley  
University of Stirling, UK

Mirko Moro, Anke Fischer, E.J.Milner-Gulland, Asanterabi Lowassa, Loiruck C. Naiman

Illegal hunting for bushmeat is regarded as an important cause of biodiversity decline in Africa. In this paper, we consider how those who buy bushmeat as a source of protein – and thus sustain the demand which results in hunting pressure – could be induced to reduce their purchases. The study is a novel application of the stated preference approach to demand estimation, using a choice experiment to elicit bushmeat consumption choices. We estimate the effects of changes in the own price of bushmeat and in the prices of two alternative, substitute protein sources – fish and chicken – for households living around the Serengeti in Tanzania. We also investigate how the sensitivity of demand for bushmeat varies across households according to factors including wealth, education, tastes and household size.

## The Potential for Fair-trade and Organic Labels for Chocolate: Good News and Bad News

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To reach the maximal potential of labels as an environmental and social policy instrument a number of assumptions need to be met. Firstly, consumers need to identify and recognize the environmental and social labels, and secondly, they also need to find the environmental quality information reliable and trustworthy. Thirdly, goods with a higher environmental quality should be more desirable than goods with a lower environmental quality. Fourthly, consumers need to have a positive marginal willingness to pay for environment-friendly goods. In order to test these conditions in practice, we performed a survey including a choice experiment of consumer decisions concerning the purchase of chocolate in Flanders (Belgium), focusing on fair-trade labels and organic labels. Overall, we find that the conditions are much better fulfilled for fairtrade labels than for organic labels in the market of chocolate in Flanders. On average, respondents even have a negative willingness to pay for labelled organic chocolate. Thus the market potential for fair-trade chocolate seems to be higher than for organic chocolate.

## **SESSION D2 - Agriculture II: Ecosystems and Water**

### **The Welfare Gain from Running Water Auctions for Agriculture in Israel**

Dafna Di Segni  
Tel Aviv University, Israel

Amity Feder, Zvika Neeman

Water for agriculture in Israel is currently allocated to farmers at fixed quantities and block rates prices. We calculate the welfare gain that would be generated by a switch into a new institutional framework: the auction one. We compare three different multi-unit auction protocols to the current institutional framework, as well as a regional vs. a state level auction on water for agriculture. Data on water pricing, water quotas and water usage within the agricultural sector in Israel is used to simulate the performance of the auctions and to estimate the social welfare generated by the different allocation methods. The bottom line is that changing the institutional framework of water allocation and water use rights is expected to generate a welfare gain of approximately six per cent to the agricultural sector.

### **Water, Native Plant Communities and Air Quality in Owens Valley, California: An Ecological-Economic Analysis of Groundwater Management Sustaining Alkali Meadow Communities**

John Gutrich  
Southern Oregon University

Keith Gigliello, Kim Vest, Andrew Elmore

A dynamic ecological economic model was created to assess the net benefits of production (i.e., economic rent) from management of groundwater while requiring the producer to sustain native groundwater dependent vegetation and associated ecosystem services. The study system was a portion of the Owens Valley, California (the Taboose-Aberdeen well-field) where groundwater withdrawal has historically (and periodically) resulted in reduced vegetation cover, the drying of springs and seeps, and reduced soil stability. Los Angeles Department of Water and Power (DWP) manages water in the Owens River basin via surface water diversion and groundwater withdrawal (over 100 active pumping wells) for export to Los Angeles over 400 km away. Groundwater withdrawal is constrained by a water agreement with the Inyo County, California, and by the Clean Air Act, which would take effect if vegetation cover is reduced sufficiently to initiate wind erosion and PM-10 air pollution.

Findings of this study indicate an adaptive approach for groundwater management (pumping high volumes in wet years and low volumes in dry years) generates more economic rent of \$82.6 million (in 2011 \$) than status quo management of \$30.5 million under baseline precipitation conditions. Costs of sustaining alkali meadow (including restoration costs and temporal loss of ecosystem services) have a present value of \$2,020/acre (\$4,989/hectare) for adaptive management compared to \$41,822/acre (\$103,300/hectare) for status quo management over 50 years. With reduced precipitation of 15% from climate change, adaptive management derived economic rent of \$41.7 million while status quo management obtained just \$4.5 million when internalizing restoration costs. Costs of sustaining alkali meadow under climate change totaled \$8,512/acre

(\$21,025/hectare) for adaptive management compared to \$53,005/acre (\$130,922/hectare) for status quo management. Adaptive management generated higher economic rent while pumping less annual groundwater at respective levels of 73% (baseline = 6,830 acre-feet) and 56% (climate change scenario = 4,952 acre-feet) of average groundwater pumping under status quo management in the well-field. Findings of this study suggest that changing to an adaptive groundwater management strategy generates greater economic rent to the producer while supplying water, sustaining native alkali meadow and ensuring air quality than the status quo groundwater management strategy.

### **A Tale of Two Villages: An Investigation of Household Land Use and Compliance under Tenure Reform in a Cambodian Protected Forest**

Henry Travers

Centre for Environmental Policy, Imperial College London, UK

Kyle Winney, Tom Clements, Tom Evans & E.J. Milner- Gulland

In this paper, we present an analysis of individual household land use change under conservation-driven participatory land use planning and indigenous tenure reform in a Cambodian protected area. The two study villages, which were both selected as pilots in the Cambodian government's nationwide land tenure reform programme, provide informative case studies with which to explore behaviour under contrasting institutional conditions. In each village, we investigated the overall level of compliance with both the boundaries of zones designated for community land use and the community regulations created to govern land use within these zones. Structured interviews and the mapping of individual plots were conducted with 114 households, with newly arrived immigrants, non-participating and participating residents included in the sample. Household behaviour was analysed to investigate the effect of different household socio-economic and demographic factors, such as the availability of labour, wealth, livelihood opportunities, age and ethnicity, on both land use and compliance. We found that household compliance was strongly correlated with total land holdings and participation in the tenure reform process. In turn, total land holdings were found to be highly correlated with the age of the household head, household wealth and whether the household had been present in the village at the time that land use planning was conducted. Compliance levels in the two villages were found to differ significantly. Our findings highlight the importance of supporting local resource management institutions created through tenure reform, particularly in the face of strong external drivers of change, and demonstrate that positive outcomes for resource conservation can be achieved through the process of defining property rights for people living inside protected areas.

## Policy Supports, Economic Incentives and the Adoption of Agricultural Water Saving Technology in China

Roger Cremades  
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Jinxia Wang, Joe Morris

Water scarcity is increasing in many parts of China due to increased demand from agriculture and other water uses and to variations in supply due to climate change. Chinese agriculture uses over 60% of the total available water. In this context, the Chinese government has promoted the adoption of irrigation water saving technologies (WST) using a range of policies, but their impacts are not known. Using data collected at field, household and village scales, the adoption of WST in response to drivers of change was explored using the Logit method with particular reference to policy interventions. It was shown that in spite of growing water scarcity, overall adoption of WST is low, and remains low in the absence of policy driven incentives and support, such as subsidies, promotional activities and technical assistance. The estimated results of the models show that they all have a good performance. The availability of subsidies has a positive and significant impact on extent and intensity of adoption of both types of modern water saving technology. The existence of extension service activities shows also a significant impact on most of the cases, but its magnitude is lower than the effect of subsidies. Finally, a proxy variable for the water price presents a positive and significant impact on the extent of adoption of household-based water saving technology. Further studies will need to be undertaken to assess how different water saving technology fit in specific geographic and environmental conditions.

## SESSION D3 - Forests

### Tanzanian Timber Markets Provide Early Warnings of Logging down the Timber Chain

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Neil D. Burgess, Ruth Swetnam, Yonika Ngaga, Steven Ngowi, Kerry Turner, Thorsten Treue

The forests of the Eastern Arc Mountains in Tanzania contribute in many ways to the welfare of local, regional and global communities, but they are under threat by on-going deforestation and degradation linked to agricultural expansion and forest and non-timber forest product extraction. In this paper we undertake an assessment of the timber flows and values, which is highly complicated as timber extraction occurs within a largely illegal system. In the absence of easily available timber sector statistics, we use market surveys and household census data to estimate extraction volumes and economic values. The estimated economic value of hardwood from the Eastern Arc amounts to more than USD 10 million per year based on market prices of planks, and twice as much in terms of final hardwood products. Hardwood forms an important source of income for people living near forests and drives an industry that creates jobs in transportation, processing and manufacturing. However, the analysis of the value chain indicates that a large proportion of profits is enjoyed by people who are not directly dependent on other forest uses, which, in combination with the illegal nature of the sector, may increase the rate of logging beyond sustainable harvesting levels. Our market data gives some clear early warning signals of unsustainable hardwood harvesting. We argue that without considerable changes to harvesting within natural forests, and the development of additional plantation forests, the supply of hardwood into the future may become erratic. However, continued harvesting at current levels will have further negative consequences on the supply of other ecosystem services including energy and drinking water supply to a large proportion of the urban population

### Understanding the Role of Livelihoods in the Adoption of Silvopasture in the Tropical Forest Frontier

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Luis Garcia Barrios, Unai Pascual

The land use in the frontier of tropical forests has an important role of buffering the ecosystem and avoiding further degradation. In this frontier, extensive cattle-farming in mountainous pasture-land entails a high risk of soil erosion and biodiversity loss. This is the case in many tropical forests and the extents of the process may expand with the fragmentation of forests that causes that the perimeter of buffer zones multiplies. Silvopastoral systems are a type of agroforestry that is a compromise between cattle-farming and the buffer function of a frontier ecosystem. Despite many projects to encourage its implementation, including payments for ecosystem services, its adoption is slow. Despite being abundantly studied, there is no general consensus on the most relevant predictors for the adoption of agroforestry because, among other reasons, the type of agroforestry practice has an important influence. There are few studies that analyse silvopasture adoption, and very few which model the level of adoption beyond the commonly used binomial variable of adoption and non-adoption. In this paper, we model the participation and the short term adoption

of silvopastoral systems in the context of a pilot project for planting fodder trees in the frontier area of a protected forest in Chiapas, Mexico. We gather cross-sectional data from 103 households about demography, income levels and livelihood strategies. We use secondary data about the level of adoption. We use a Heckman selection model to model both the participation and the level of adoption. The variables that influence participation in the program are different from the variables influencing the success in the activities encouraged by the program. Results also show that livelihood strategies are significant to predict participation and level of adoption, although the direction of their effect may be different for each. This has relevant implications for the design and targeting of programs for conservation in the context of development.

### Unintended Consequences of Anti-Corruption Strategies: Public Fiscal Audits and Deforestation in the Brazilian Amazon

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Jorge Hargrave, Krisztina Kis-Katos

This paper documents an increase in deforestation in Amazon municipalities as a consequence of the otherwise successful federal anti-corruption strategy in Brazil. We rely on the unique policy experiment of fully randomized public fiscal audits to identify the causal effects of the audits on deforestation and to assess governance quality at the municipality level. Deforestation increased on average by at least 11% in the aftermath of public fiscal audits, with larger increases in more corrupt municipalities. Municipalities seem also to have learned from neighboring audits, which affected deforestation outcomes in a similar way to their own audits. Deforestation increased especially under mayors who were facing reelection constraints and received unfavourable audit reports. All these findings can be reconciled with a shift in illicit/corrupt activities towards spheres less easily observable by federal auditors.

### Baseline Choice and Performance Implications for REDD

Anca Pana  
University of Zurich, Switzerland

Jonathan Gheysens

The significant contribution of deforestation to global CO<sub>2</sub> emissions has recently favored the emergence of new schemes (REDD and REDD+), which offer carbon payments in exchange for reductions in emissions from deforestation. These price instruments target deforestation levels below business-as-usual scenarios, therefore requiring a good understanding of the differences between alternative baseline approaches. While multiple baseline schemes have been proposed in the past, this paper is, to the best of our knowledge, a first attempt to specifically assess their impacts on deforestation levels and REDD efficiency in a dynamic setting. Using a general timber extraction model, we compare the emission performances, efficiency ratios, and potential welfare impact of three different baseline models that cover a large spectrum of the proposed schemes for future REDD projects. We find that amongst the tested schemes, a corridor baseline method provides the most successful results on all our requirement criteria (effectiveness, efficiency and forester's welfare). Our study is also exploring further ways of improving baseline performance,

by playing with design features, namely corridor width and symmetry. We individuate a symmetric and narrow variable corridor 2 as the best performer, offering top results in terms of effectiveness in reducing emissions from deforestation, guaranteeing at the same time a positive though modest increase in welfare, achieved at medium performing efficiency levels.

## **SESSION D4 - Behavioural Economics and Environmental Policy**

### **The Role of Risk, Ambiguity and Time Preferences in the participation in Renewable Energy PES Programmes: Experimental Evidence from China**

Pan He

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Stefanie Engels, Marcella Veronesi

Using renewable energy sources to substitute for traditional energy materials such as firewood can reduce CO<sub>2</sub> emissions and deforestation. This paper explores the role that risk, ambiguity, and time preferences play in the participation in renewable energy Payments for environmental services (PES) programs, and uses as a rural biogas program supported by government bond funds in China a case study. The most recent experimental methods are employed in the field to elicit the preference parameters. We find that (i) risk preferences affect farmers' participation in the biogas PES program, while ambiguity and time preferences have insignificant effects; (ii) farmers who are more risk averse are less likely to participate in the biogas program; (iii) the effect of risk preferences is significant only for impatient people, suggesting an interaction of risk and time preferences. We confirm the validation of the latest laboratory experimental methods, and the stability of laboratory experimental findings in the field. In addition, we go beyond expected utility theory by testing prospect theory in the field. Our findings support expected utility theory rather than prospect theory, suggest that people make rational choices and have tiny present bias, and that the utility function for certainty and uncertainty may be different

### **Characterizing Commercial Cattle Farms in Namibia: Risk, Management and Sustainability**

Roland Olbrich

Leuphana University of Luneburg, Germany

Martin Quaas, Stefan Baumgartner

Commercial cattle farming in semi-arid regions is subject to high rainfall risk. At the same time it is prone to rangeland degradation, and theoretical works suggests that this may be due to inadequate management of the rainfall risk. In this paper, we provide a comprehensive empirical characterization of Namibian commercial cattle farming with respect to rainfall risk, risk management, and sustainability. Our data comes from an extensive survey among 2,119 farmers. With this data, we examine the critical link between risk, management and sustainability by exploring structural farm patterns with a cluster analysis. Our results show that the most distinct of the three identified clusters is characterized by high grazing capacity (indicating high sustainability) and low financial risk management, but not by high or low income. These results conform to the hypothesis that (financial) risk management may achieve income risk reduction at the cost of a decrease in the system's sustainability.

## A Bird in the Hand is worth two in the Bush: Ecological Time Preference and Biodiversity Offsets

Megan Evans

Australian National University, Australia

Martine Maron, Philip Gibbons, Hugh P. Possingham

Biodiversity offsetting is an increasingly popular yet contentious measure used to compensate for the ecological impacts of development. Much of the research focus on biodiversity offsetting has been on developing metrics for quantifying the amount of offset required to achieve a 'no net loss' or 'net gain' of biodiversity. Although the majority of metrics in use take into account the spatial dimension of impact, few consider the time required for an offset to fulfill its compensation requirements to a particular species or ecosystem. Given that the future prospects of biodiversity is inextricably linked with time, surprisingly little work has been undertaken to quantify the offset requirements for threatened species and ecosystems which face varied degrees of threat to their persistence. In this study, we introduce a novel approach to comprehensively estimate the offset requirements for biodiversity impacts over time and space, by incorporating the species' annual probability of extinction as a discounting factor within our loss-gain metric. We find that accounting for 'ecological time preference' within our loss-gain metric results in greater offset requirements for threatened species and ecosystems, but offset burden can be reduced if compensation can be delivered more rapidly. Our approach can utilise readily available estimates of the probability of extinction related to the IUCN threat status of Red Listed species and ecosystems, but could benefit from refined estimates of annual extinction probabilities for specific biodiversity elements.

## Adaptation to Climate Change and Climate Variability: Do it Now or Wait and See?

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Kiel Institute for the World Economy, Germany

Martin Quaas

As growing attention is paid to climate change adaptation as an actual policy issue, the significant meaning of climate variability in adaptation decisions is beginning to be recognized. By using a real option framework, we shed light on how climate change and climate variability affect individuals' (farmers') investment decisions with regard to adaptation. Significant effects of the option value – it delays adaptation easily for several decades with a realistic set of parameter levels – implies a critical role of risk sharing in promoting adaptation. When variability-influenced adaptation involves the use of an open-access resource (water), uncoordinated farmers may adapt too early or too late depending on the level of their risk aversion. Private adaptation should be supported or deterred accordingly if farmers are not convinced about the possibilities of collective resource management in the long run

## SESSION E1 - Economics of Ecosystem Services II

### The Economics of an Ecosystem Service: The Case of Natural Pollination

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There has been tremendous recent enthusiasm among conservation advocates for “ecosystem services”. The idea is to show that natural areas can be shown to provide valuable goods and services, and should, therefore, be preserved. While there has been great interest in ecosystem services, the evidence for their value has thus far been limited. In this paper I consider one service that has attracted considerable interest from researchers and advocates: pollination.

Insects, birds, and other organisms that transfer the pollen necessary to fertilize many valuable crops benefit from the preservation of areas of natural habitat in which they can nest and find alternative food sources when crops are not in season. Do the services afforded by such pollinators provide strong incentives for the conservation of their habitats? Simple economics and casual empiricism suggest that they may not. Conservation incentives are determined by economic value, and economic value is determined on the margin. So, what is the “marginal pollinator” worth? The answer depends on three factors: the price of the output to which it contributes, the number of seeds the pollinator could fertilize, and the probability that a seed fertilized by the “marginal pollinator” would not have been fertilized by any of the other of its species, or of other species, or by wind-borne pollen, or by any other means.

If pollinators are plentiful this last factor will be small, and so the marginal pollinator would not be of much value. Let us suppose, though, that pollinators are scarce, and hence valuable. But if they are valuable it is because many plants are likely to go unfertilized, and thus that crop losses for want of pollination are high. This, in turn, means that the price at which crops can be sold must substantially exceed the costs of planting them. If another farmer can plant the same crop at a similar cost and sell it at a similar price, he could undercut the farmer who benefits from fewer pollinators. This would seem to describe what is happening in many areas of the world however: it is not clear that there is a market failure in pollination; it may just be that production is locating in the regions that enjoy a comparative advantage in the necessary inputs.

In this paper I develop a simple but, I would argue, revealing model of the value of pollination services that demonstrates the above results. I argue that the biological literature supports my interpretation. This demonstration that the value of one ecosystem service may not provide strong conservation incentives does not necessarily cast any light on the value of any others, but does show that it is important to think carefully and critically about the economic case for conservation.

## The Relationship between Intragenerational and Intergenerational Justice in the use of Ecosystems and their Services

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Conflicts between intragenerational and intergenerational justice in the use of ecosystems and their services may arise in the design and implementation of sustainability policy. We present a model that depicts the relationship between intragenerational and intergenerational justice ('justice-relationship') against the backdrop of given ecological, economic and societal circumstances. These system determinants include the quality and quantity of ecosystem services, population development, substitutability of ecosystem services, technological progress, institutions, and political restrictions on redistribution. With this model, we numerically simulate how different assignments of resource utilization rights to potential ecosystem users impact on the justice-relationship depending on system determinants.

## Economic Growth, Population Dynamics and the Value of Land Reserves: An Integrated Assessment

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We study the macroeconomic effects of the continued conversion of natural land reserves to agriculture. We formulate a two-sector endogenous growth model that captures a number of features that are specific to agriculture: (i) agricultural output determines the size of the sustainable human population; (ii) agriculture requires land as an input; and (iii) the expansion of cultivated lands reduces biological diversity and favors the occurrence of pests and pathogens, generating a land conversion externality. This framework captures the indirect effects of land conversion on population dynamics through the likelihood of famine events, suggesting a role for preservation policies at the global level.

## SESSION E2 - Agriculture III: Information

### Farmer Bargaining Power and the Market Information Services

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In many Sub-Saharan African countries, farmers typically have a choice between selling their products to traders who travel between villages and markets and transporting their products to the nearest market themselves. Because of communities' remoteness and poor communications with marketplaces, farmers' uncertainty about market prices is usually high. Traders may take advantage of farmers' ignorance of the market price and extract a rent from them by offering very low prices for their products. In this article, we model bargaining interactions between a farmer and a trader who incur different transportation costs, and we study how price information affects the bargain and the balance of power. We then estimate the causal effect of a Market Information System (MIS) working through mobile phone networks on Ghanaian farmers' marketing performances. We find that farmers who have benefited from the MIS program received significantly higher prices for maize and groundnuts: about 12.7% more for maize and 9.7% more for groundnuts than what they would have received had they not participated in the MIS program. These results suggest that the theoretical conditions for successful farmer use of MIS may be met in field.

### Switching to Semi-Perennial Energy Crops: Real Options and Investment Timing?

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Semi-perennial crops, once planted, can be harvested for several periods. This multi-yield character results in an opportunity cost of abandonment that affects optimal conversion decisions in a way that is reminiscent of conventional conversion costs. In the presence of uncertainty, when it is possible to choose between annual and semi-perennial crops, the possibility of benefitting from a stream of harvests entails some hysteresis in favor of the latter, even if conversion costs are nil. In particular, this analysis accounts for recent evidence that sugarcane { a semi-perennial crop used for ethanol production in Brazil { has a low elasticity to price changes.

## Innovation and IPRs for Agricultural Crop Varieties as Intermediate Goods

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The trade-offs involved in the extent of appropriability conferred by intellectual property right (IPR) protection to innovators remains an area with many unanswered questions. This paper considers the case of IPRs for product innovations where the product is an intermediate good used to produce a final consumer good. Producers of the final good purchase an innovation from a monopolist, represented in a vertical product differentiation framework. The innovation is subject to an IPR for which the extent of appropriability is determined by a policy maker. The analysis reveals some novel aspects of the traditional innovation versus diffusion trade-off. More productive producers of the final good benefit from stricter appropriability and the resulting higher level of innovation. Less productive producers, and also consumers, are better off with a moderate level of appropriability. The paper is motivated by the agricultural sector in which an innovator uses genetic resources to produce new crop varieties to be marketed to a farm sector that displays heterogeneity in its ability to profit from the innovation. The scope of the exclusive rights granted over plant varieties has increased in various countries over the past four decades, partly as a result of the TRIPS Agreement, and has been the subject of much policy debate at international, as well as national, levels, partly given potential implications for food security. For these reasons, the model is extended to a two country setting consisting of North and South, which highlights both the interest of the South in maintaining lower levels of appropriability, but also the pressure from farmers in the North for the South to raise its standards. This would not necessarily benefit global consumers.

## **SESSION E3 - Environmental Policy II**

### **Understanding Stakeholders Prioritization of Invasive Plants**

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Touza J., Pérez-Alonso A., Chas-Amil M.L., Dehnen-Schmutz K.

Debates surrounding the use of prevention and control policies to avoid further spread of invaders have highlighted the need to establish priorities in public resource allocations. The aim of this study was to explore the consistency or discrepancy among stakeholders involved in the risk and control management of invaders in order to identify the extent to which different factors, including media coverage may influence stakeholder choices of major relevant plant invaders. We focus on the process of stakeholder ranking of invasive plants to explore the reasons behind stakeholders' support on policy management that affect these invaders. Data were collected through semi-structured interviews in Galicia, Spain, where a catalogue of prohibited entry and trade of invasive species is currently in the public debate arena. We estimate a rank-ordered logit model that uses information from semi-structured interviews that were conducted with several groups of stakeholders: the public administration sector, the ornamental sector, research and social groups. The characteristics of plant invaders that provoke stakeholders to rank higher are, a wide distribution of plant invasion, the existence of public control programmes, the use and sale of the species in the ornamental sector and the level of media coverage. Stakeholder groups differ in the influence these aspects have in their ranking

### **Creating an Environmental Commodity: The Impact of Alternative Metric Structures on Relative Investment Values in the Environmental Stewardship Program in Australia**

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Created environmental markets such as conservation tenders and biodiversity offsets employ a metric as a way of comparing the relative environmental value offered by alternative options in the market. Largely driven by ecological theory, these metrics have received little attention by economists yet are the critical linchpin that defines the nature of the values that are traded in markets. In this paper we describe some of the features required by a suitable metric in an environmental market. We then examine what the implications of deviation from these features are for the efficiency of one environmental market – the Australian Government's Environmental Stewardship Program – via a case study of the different metric formats employed as the program has evolved from 2008 to 2012. Our preliminary results suggest that there is little divergence in the efficiency or other measures of performance for different benefit estimates within a single metric functional form. In contrast, different functional forms, even when closely related, deliver substantive differences in investment efficiency across two metrics examined. These results are sufficiently encouraging to motivate deeper analysis across a larger combined data set and three different metric forms.

## Impacts of Population and Income Growth Rates on threatened Mammals and Birds

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Per capita income and human population levels have direct influences on environmental outcomes of a country. Countries with the same level of income (population size) may have a different rate of income (population) growth and vice versa, suggesting that the influence of the rate of income (population) growth on environmental outcomes could be different than that of income (population) level. We explore this empirical question using country-level data on threatened species published by the International Union for Conservation of Nature for the year 2007. Controlling for other factors, including influences from neighbouring countries, our model estimates the impacts of the rate of income and population growth on threatened mammals and birds across 113 continental countries. The results suggest that, among other factors, the rate of population growth during 1970 to 1990 has a significant influence on the number of threatened birds in a country.

## **SESSION E4 - Fisheries IV**

### **Fishery Resources and Trade Openness: Evidence from Turkey**

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Jean-François Jacques

In this study, we investigate whether the trade in fish and fish products contributed to the decline of 57 fish species observed from 1996 to 2009 in Turkey. The overall purpose is to test the theoretical findings of Brander and Taylor (1997) who argue that a small open economy exporting an open-access renewable resource will experience increased resource depletion. To this end, we estimate a reduced form of Brander and Taylor (1997) using a panel data model. We carry out estimations based on two different samples: when the fish exports are positive and when they are absent. Estimation results reveal a backward-bending supply curve for the fish harvest in both cases. This finding indicates that fish stocks are under pressure for the whole fishery sector no matter the fish is exported or not. This is due to ill-defined property rights which govern fishery resources in Turkey.

### **Windows of Opportunity for Sustainable Fisheries Management : The Case of Eastern Baltic Cod**

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Bernd Klauer, Thomas Petersen, and Johannes Schiller

Overcoming the persistent overfishing problem requires a transition from the current business as usual, which is characterized by small, overfished fish stocks, large fishing effort with many fishermen and fishing vessels employed, and low catches, towards a more sustainable fishery. We study under which conditions a 'window of opportunity' for sustainable fishery management arises, i.e. a situation where the interests of the different groups (in particular consumer and worker surpluses) are aligned with the objectives of sustainable fishery management. We quantify the effects for the Eastern Baltic cod fishery and show that at very low stock sizes all interest groups unanimously prefer maximum-sustainable-yield management over the overfishing situation. A long-term commitment is needed, however, as with increasing stock sizes interests of fishermen and consumers may change and their present values of welfare would be higher when switching back to overfishing again.

## European Fisheries Policy and the Common Pool Problem in the Council of Ministers

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Martin Quaas

The Council of Ministers which is responsible for European fisheries management, has set inefficiently generous total allowable catches (TACs) in the past. To study why this has been the case, we develop a model which describes the annual voting on TACs as a dynamic game with feedback strategies in discrete time. We consider two types of ministers, with one type being more patient than the other one. We show that the resulting TAC levels are inefficiently high and can even be close to open access levels. The underlying cause for this 'common-pool problem in the Council of Ministers' is the uncertainty about future majorities and decision making in the Council. We conclude that more sustainable fishery management requires binding long term commitments instead of annual votes.