Joseph William BULL[1]
Niels STRANGE[2]

DEMONSTRATING BIODIVERSITY OFFSET POLICY OUTCOMES USING THE CLASSIC "TRADING IN A PIT MARKET" CLASSROOM GAME

[1] PhD in Ecology, Marie Skłodowska-Curie Fellow,
Department of Food and Resource Economics,
Center for Macroecology, Evolution and Climate,
University of Copenhagen (Denmark)
jwb@ifro.ku.dk

[2] PhD in Management Planning of Forest and Nature, Professor,
Department of Food and Resource Economics,
Center for Macroecology, Evolution and Climate,
University of Copenhagen (Denmark)
nst@ifro.ku.dk

Abstract

"Biodiversity offsetting" is a novel approach to nature conservation, through which it is intended to dissociate economic development from negative biodiversity impacts. Biodiversity offsets involve the quantification of the predicted biodiversity losses associated with a given development project, and subsequently, the provision of full ecological compensation measures elsewhere by the associated developer, e. g., habitat restoration. The objective is no net loss of biodiversity overall.

Here, we develop an offset experiment in the style of a classic economic game ('trading in a pit market'), which can be implemented for teaching or training purposes. Our purpose was twofold: first, to illustrate to non-experts how biodiversity offsetting is supposed to work; and second, to gather a novel form of data on how offset policies might play out in practice. We ran the experiment with three different groups of students in 2016: two at the University of Copenhagen in Denmark, and one at the Swedish Agricultural University in Sweden.

The experiment provided an engaging means for teaching students about the concepts underlying biodiversity offsets. Furthermore, the trade data collected from students in

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running the experiment, with and without a hypothetical biodiversity offset policy in place, revealed some key principles around offsetting which have been noted in real world policy outcomes.

Keywords

Biodiversity offset, no net loss, trading pit.

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Introduction

Nature conservation is considered an important goal by the global community, as evidenced by the fact that 196 nations are now party to the Convention on Biological Diversity [6] and associated conservation targets. However, many of the activities associated with industrial development and economic growth are known to have negative impacts upon nature [14]. As a result, governments, large businesses and financial institutions worldwide are keen to identify mechanisms through which biodiversity loss can be dissociated from economic development [13]. One increasingly widespread option for potentially doing so is to implement some form of 'no net loss' biodiversity policy principle, which includes allowing developers to implement 'biodiversity offsets'.

Biodiversity offsets basically involve the quantification of predicted biodiversity losses associated with a development project, and subsequently, the provision of full ecological compensation measures elsewhere by the associated developer, e. g., by habitat restoration [3]. Biodiversity offsets are intended to be used as a last resort, after reasonable efforts have been made to avoid, minimise and remediate project impacts wherever feasible [8]. The underlying assumption is that, if all biodiversity impacts of development can be (i) avoided, (ii) minimized, (iii) remediated and then finally (iv) offset (where actions i–iv represent a preferred sequence of measures together known as the 'mitigation hierarchy'; Fig. 1), then there will be no net loss (NNL) of biodiversity overall.

Modern NNL-type policies, and thus biodiversity offsetting, have been in place since at least the 1970s [13]. In this article, we focus upon biodiversity offsets (henceforth, 'offsets').

The potential outcomes of offset policies over time and at a landscape scale can be predicted through mathematical simulation models [e. g. 2; 10; 15]. Furthermore, previous studies have captured the stated preferences of different stakeholder groups in terms of the desired outcomes of biodiversity offsets [4; 5; 12; 17]. However, the few countries that have witnessed the widespread implementation of offsets (such as Australia, Germany, and the US [13]) do not have sufficiently accurate monitoring data to allow any general demonstration of the actual outcomes of offsetting [e. g. 1]. This is a problem in terms of: (a) understanding how offsets might work in practice; (b) understanding whether they are likely to be effective; and, (c) explaining to those without any previous expertise how an offset policy could and should be implemented.

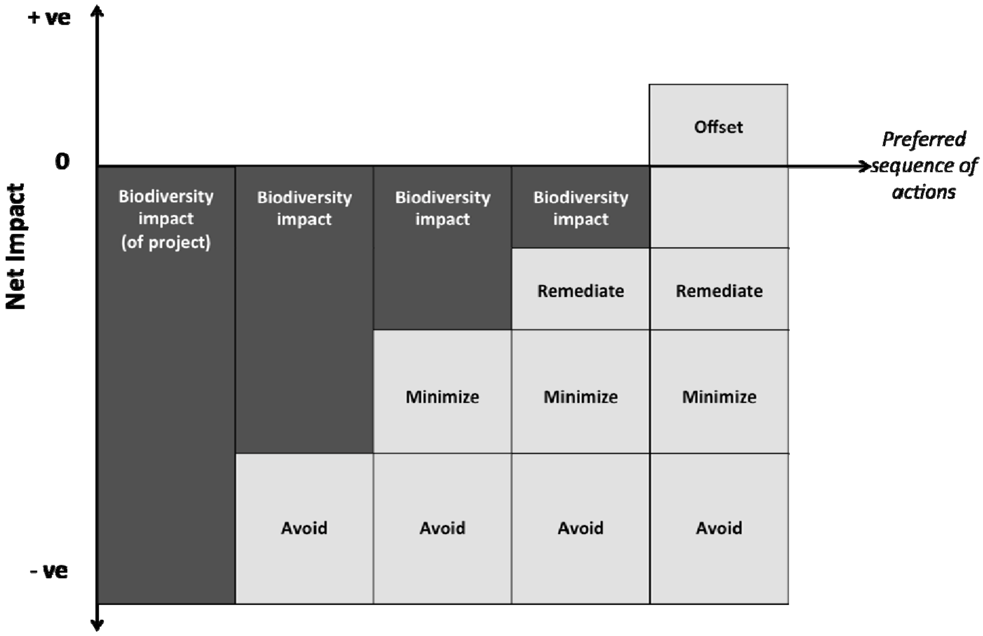

Fig. 1. Schematic of the ‘mitigation hierarchy’. Net biodiversity value is plotted on the y-axis. A development project is predicted to result in net losses (dark shaded bar). A sequence of avoidance, minimisation, remediation and finally offset actions (all light shaded bars) are then implemented to mitigation and compensate for predicted development impacts. The final result, ideally, is that net biodiversity value = 0 (i. e. ‘no net loss’) or better [3; 8; 13]

Рис. 1. Схема «иерархии смягчения». Чистое значение биоразнообразия нанесено на ось y. Проект развития предположительно приведет к чистым убыткам (темно-серая область). Последовательность действий исключения, минимизации, исправления и, наконец, смещения (все светло-серые полосы) затем применяются для смягчения последствий и компенсации прогнозируемых воздействий развития. Конечный результат, в идеале, заключается в том, что чистое значение биоразнообразия = 0 (т. е. «без чистых убытков») или лучше [2; 7; 13]

Here, we developed an offset experiment in the style of a classic economic game, which can be played by students or employees (for teaching or training purposes, respectively). The purpose was twofold: primarily, to illustrate to non-experts how offsetting is supposed to work (i. e. point (c) above); and secondarily, to gather a novel form of data on how offset policies might play out in practice (i. e. points (a-b) above).

Experimental method

We used the ‘trading in a pit market’ game outlined by Holt [11], which has been used extensively to teach students about the classic macro-economic concepts of supply and demand, and market equilibrium. Holt divided a given class of students into two groups, 'buyers' and 'sellers', which then all traded playing cards of different nominal values by bartering in an open market. The value of each trade was recorded over several rounds of trading, and at the end the trade data from the game is used to demonstrate how markets settle into a predictable equilibrium.

Offsets were designed in a number of countries as a form of tradable permit [18], and so it was appropriate to adapt an existing market trading game as a model for the implementation of an offset policy. We therefore adapted the experiment outlined by Holt [11] slightly such that our class of students was divided equally into 'developers' and 'landowners', and each trade resulted in the modification of a plot of land demarcated on a map. A real case study landscape located in Vejle Ådal and surroundings west of Vejle (Figs. 2 and 3). Vejle Ådal is a river valley formed by the last glacial periods some 115–15 thousand years ago. The glaciers followed the valley systems previously formed back in the older part of the Quaternary or earlier. The glaciers deepened the valley and runoff from melted ice and snow eroded the valley bottom

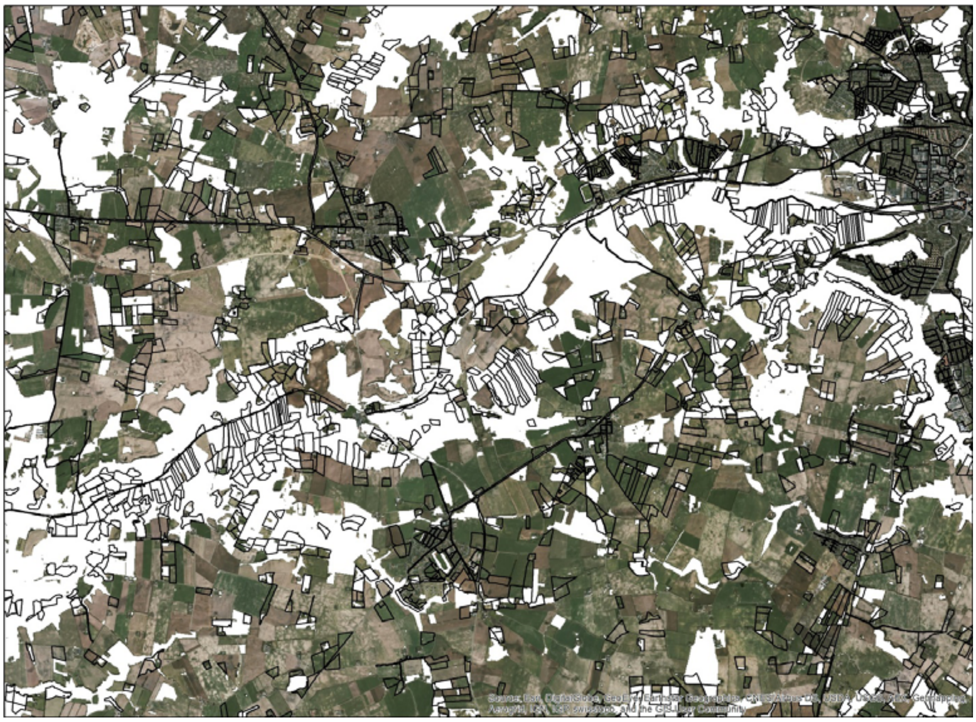

Fig. 2. Vejle Ådal and surroundings west of Vejle. The white areas indicate areas of High Nature Value, and parcels of between 1 and 5 ha which in this exercise are either considered suitable development or off-setting

Рис. 2. Вайле-Адаль и окрестности к западу от Вайле. Белые области обозначают районы с высокой природной ценностью и участки от 1 до 5 га, которые в этом упражнении считаются подходящими для развития или смещения

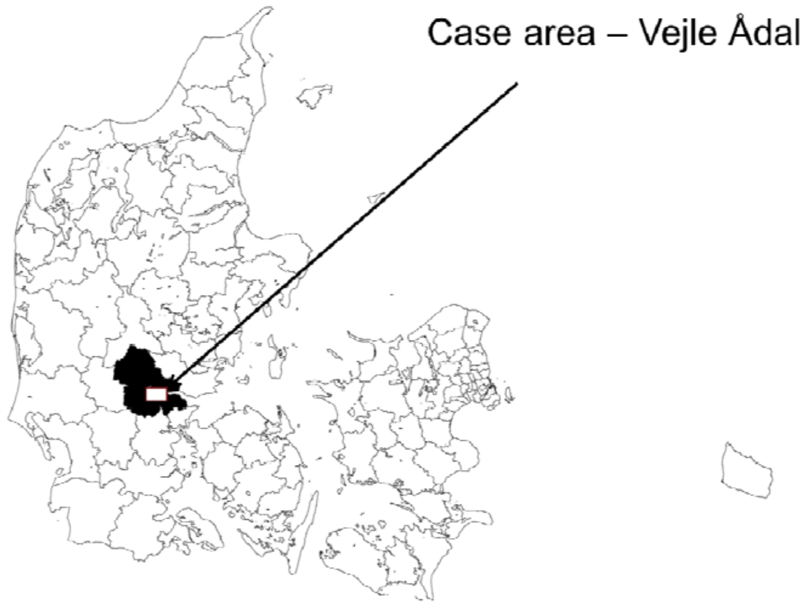

Fig. 3. Location of the case area, Vejle Ådal

Рис. 3. Расположение исследуемого места, Вайле-Адаль

and sides. Today the valley is an important biodiversity hotspot and includes wetland habitats and dry grassland on steep slopes of high nature value (HNV). Despite this the area is not included in the Natura 2000 areas network. Fig. 2 illustrates the case area, which is situated west of Vejle. The white areas indicate areas which have been assessed as holding HNV [7].

Parcels of approximate similar size (1-5 ha) within and outside the HNV areas are marked. We assume that each land parcel is owned by one owner and each land parcel within the HNV areas (white polygons) are interesting development areas, most likely conversion into intensively managed farm land, or housing development if allowed by the municipality. Fig. 3 illustrates the location of the case area in Denmark.

The students then played two different games in succession, in which they first traded plots of land for development without an offset policy, and then traded plots of land for development with a requirement to also implement offsets (see below). We ran the experiment with three different and independent sets of students, all of whom: had had no previous training in biodiversity offset policy; ranged from undergraduate to doctoral level; and represented a range of nationalities and both genders. The students were being taught on three different and entirely unrelated courses: two at the University of Copenhagen in Denmark, and one at the Swedish Agricultural University in Sweden.

Details: Game 1

We gave each developer a red numbered playing card, and each landowner a black numbered playing card. Some cards were removed from the deck(s), and all remaining cards had a number. Each unit on the card represents one "unit" of trade that can be exchanged between developers and landowners, and all participants kept the number on their card secret as private information. This was to resemble a real market situation in which only landowners knew their true costs, and the minimum price at which they would sell (elaborated below). The cards were distributed to students at random, from a selection of cards designed such that the average across all cards handed out was 6. For example, the following cards would be used for a class with 18 student participants:

Black (spades or clubs): 2, 2, 3, 4, 5, 6, 6, 7, 8.

Red (hearts or diamonds): 10, 10, 9, 8, 7, 6, 6, 5, 4.

Trading: all developers and landowners met in the centre of the room and were allowed to freely negotiate a price for the plot of land owned by each landowner, based on the value of the cards in their hand, for a 5-minute trading period. Prices had to be multiples of 0.5. When a developer and landowner agreed on a price, they went together to the game administrator (the authors) and reported the exchange, which upon approval was then announced to the whole class. Trades were approved when the agreed price was at or between the minimum price of the landowner (seller) and the maximum price of the developer (buyer). They then turned in their cards, and the developer chose a **white** land parcel on the map (see case study) to colour in **red** (known as the 'development'). Afterwards, both were out of the game for that period. There were four periods of trading.

Landowners: could sell a single card during a trading period. The number on the card is the dollar cost that incurred if a sale is made. Landowners were required to sell at a price no lower than the cost number on the card. Earnings on the sale were calculated as the difference between the price negotiated and the cost number on the card. If no sale was made, nothing was earned. So — suppose that the card had a value of 2 and a sale price of $3.50 was negotiated. The landowner would earn $3.50 – $2 = $1.50. They would not have been allowed to sell at a price below $2 with that card.

Developers: could each buy a single development plot during the trading period. The number on their card is the dollar value received if a purchase is made. Developers were required to buy at a price no higher than the value number on their card. Their earnings were calculated as the difference between the value number on their card and the price negotiated. Again, if no purchase was made, nothing was earned. So — suppose that the card was a 9 and a purchase price of $4 was negotiated. The developer would earn $9 – $4 = $5. They would not have been allowed to buy at a price above $9 with that card.

Recording Earnings: After each period, the administrator collected all cards, and students calculated their earnings whilst cards were redistributed at random. Each student's total earnings equalled the sum of earnings for units traded in all periods, and we used the Earnings Record Form from Holt (1996; Table 1). Landowners used the left side of the Earnings Record Form, and developers used the right side.

Details: Game 2

The approach in Game 2 was similar to those in Game 1, but with a major difference. Every time a developer bought a card from a landowner, they also had to buy a second card as an "offset" for the development. When a developer had both bought a first card as a development and also a second card as an offset, they could then come to the administrator as before to report both at the same time. The developer coloured

Table 1

Earning Record Sheet (copy on the reverse of the instruction sheet)

Таблица 1

Лист для записывания поступлений (копия обратной стороны листа с инструкциями)

name:____________________

Seller Earnings (sellers use this side)						Buyer Earnings (buyers use this side)				
____ (price)		____ (cost)	=	____ (earnings)	first period	____ (value)	–	____ (price)	=	____ (earnings)
____ (price)	–	____ (cost)	=	____ (earnings)	second period	____ (value)	–	____ (price)	=	____ (earnings)
____ (price)	–	____ (cost)	=	____ (earnings)	third period	____ (value)	–	____ (price)	=	____ (earnings)
____ (price)	–	____ (cost)	=	____ (earnings)	fourth period	____ (value)	–	____ (price)	=	____ (earnings)
____ (price)	–	____ (cost)	=	____ (earnings)	fifth period	____ (value)	–	____ (price)	=	____ (earnings)
____ (price)	–	____ (cost)	=	____ (earnings)	sixth period	____ (value)	–	____ (price)	=	____ (earnings)
____ (price)	–	____ (cost)	=	____ (earnings)	seventh period	____ (value)	–	____ (price)	=	____ (earnings)
total earnings, for all periods:				$ ____		total earnings, for all periods:				$ ____

one **white** land parcel on the map **red** (the 'development') and one **white** land parcel on the map **green** (the 'offset').

Additional rules for Game 2 were:

— developers could not purchase a card for the next 'development' until they had purchased an offset for the previous development;

— developers could buy the two cards (development and offset) in any order;

— developers could buy the two cards (development and offset) from the same landowner, or different landowners; and,

— the developer had to use the same card to buy both the development and the offset cards.

Results

Trades performed by all three sets of students — labelled the 'INC' (Denmark), 'JSM' (Sweden) and 'NLP' (Denmark) groups, approximately converged to the theoretically predicted market equilibrium (= 6; [11]) under Game 1 (Fig. 4).

The market equilibrium value was significantly lower on average in Game 2 (= 4.0 ± 0.5), when the offset policy was implemented, than in Game 1 (= 5.5 ± 0.3). The number of trades was also significantly lower on average (Table 2).

We noted that participants in each class voluntarily (i. e. without being prompted) requested to play a third version of the game, in which developers were permitted to increase the value on their card so as to make purchasing two plots of land (a development and an offset) more straightforward. In each case, the third version of the game was played as requested.

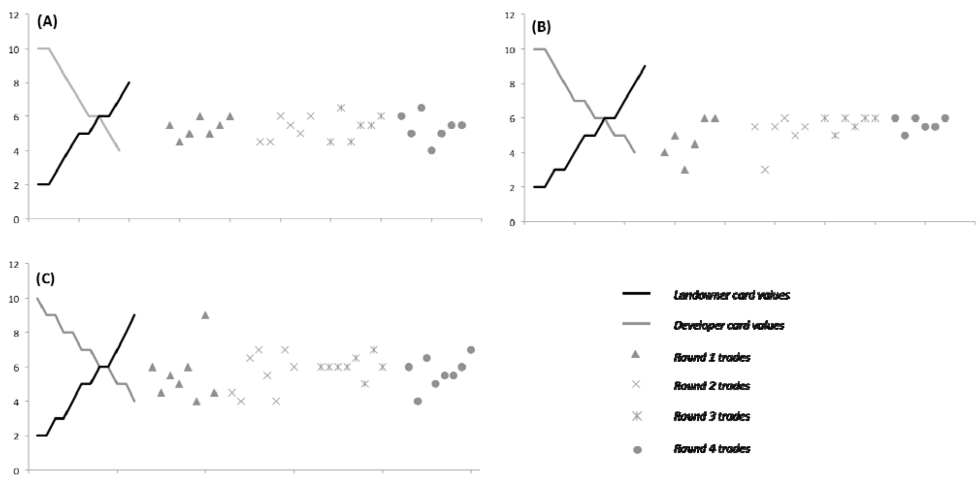

Fig. 4. Results of each round of Game 1, for all participants. Theoretical market equilibrium value = 6. (A) INC course (Denmark), (B) JSM course (Sweden), (C) NLP course (Denmark)

Рис. 4. Результаты каждого раунда игры 1 для всех участников. Теоретическое рыночное равновесное значение = 6. (A) Курс INC (Дания), (B) Курс JSM (Швеция), (C) Курс NLP (Дания)

We mapped development and offset locations chosen by the first of the three students groups over the three versions of the game (Fig. 5).

Discussion

First and foremost, we received highly positive feedback from those taking part in the game. As mentioned, all student groups requested to play additional (third) versions of the game, suggesting enthusiasm for the exercise. A number of students expressed the perspective that it was interesting (as those studying environmental science) to both be exposed to economic theory, and thought-provoking to be put in the position of the developer. The course director for the first group of students (INC) contacted us to state that the group had very much enjoyed the experiment. As such, we suggest that the games presented here could potentially be used as an engaging tool for teaching classes about offsetting and NNL theory. Additionally, the games perhaps provide a useful method for communicating the concept behind offset policy to those in a region where an offset policy is to be introduced.

Table 2

Trades completed by all three groups of students for Games 1 and 2, in terms of average trade value and average number of trades completed

Таблица 2

Торги, проведенные всеми тремя группами студентов для Игр 1 и 2, с точки зрения средней торговой стоимости и среднего числа завершенных торгов

		STUDENT GROUP			TOTAL	
		INC	JSM	NLP	Mean	SD
	No. participants	19	19	25		
Game 1	Average trade value				5.5	0.3
	Round 1	5.4	4.8	5.6		
	Round 2	5.3	5.1	5.6		
	Round 3	5.4	5.8	6.1		
	Round 4	5.4	5.7	5.7		
Game 2	Average trade value				4.0	0.5
	Round 1	4.0	4.0	3.0		
	Round 2	4.4	4.4	3.3		
	Round 3	4.4	4.0	-		
	Round 4	4.4	4.6	-		
Game 1	Number of trades				6.8	0.9
	Round 1	7	6	8		
	Round 2	6	6	8		
	Round 3	6	6	8		
	Round 4	7	6	8		
Game 2	Number of trades				4.6	1.0
	Round 1	4	4	4		
	Round 2	4	4	6		
	Round 3	6	4	-		
	Round 4	4	6	-		

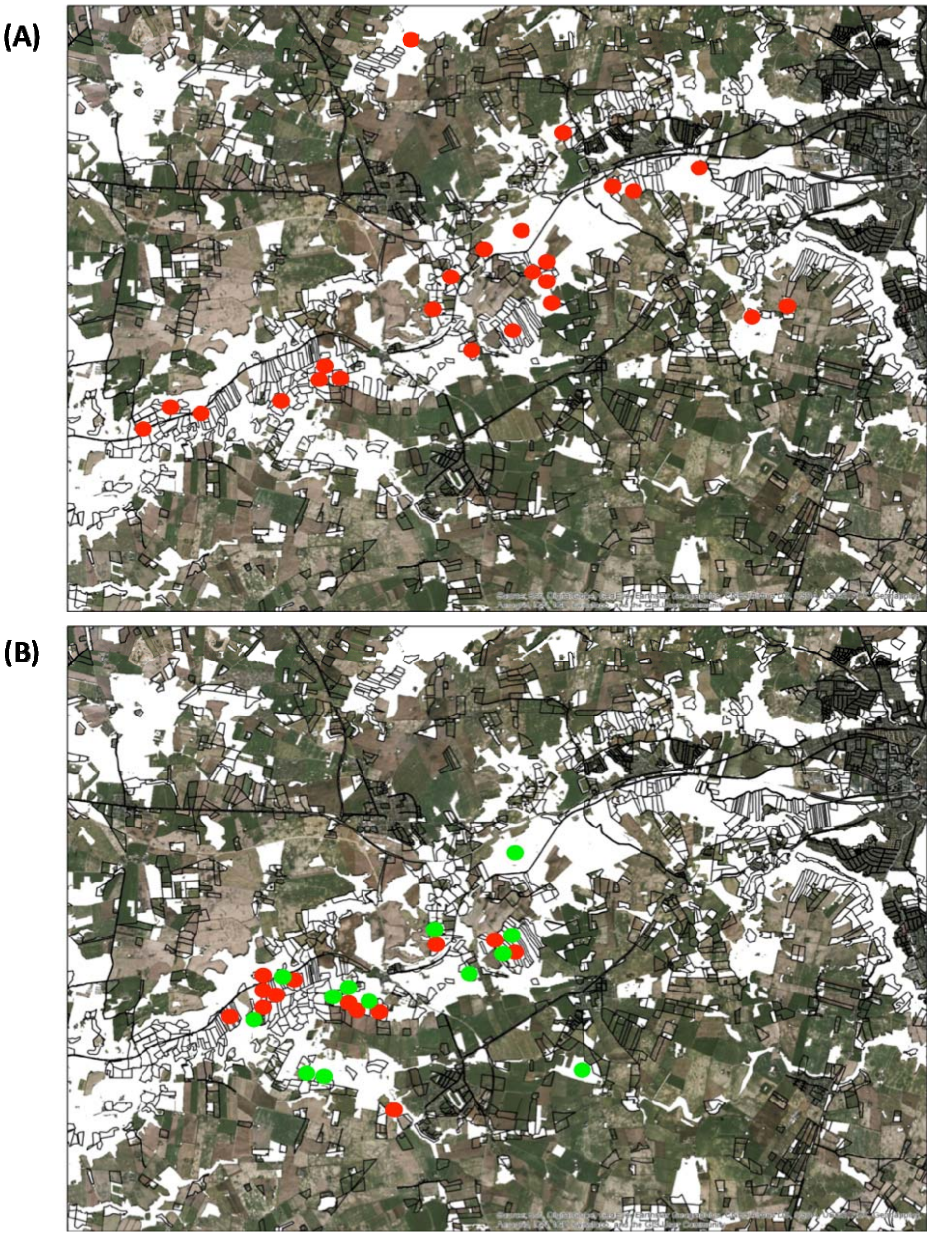

Fig. 5. Example map of development and offset locations, chosen by the INC class. (A) Game 1, where red dots = location of developed sites. (B) Game 2, where red dots = location of developed sites, and green dots = location of corresponding offset sites

Рис. 5. Пример карты местоположений разработки и смещения, выбранных классом INC. (A) Игра 1, где красные точки = местоположение разработанных участков. (B) Игра 2, где красные точки = местоположение разработанных участков, а зеленые точки = расположение соответствующих смещенных участков

Furthermore, despite the small sample size and hypothetical nature of the game, the outcomes of the experiment reported above reveal some important points about biodiversity offsetting. For instance, the introduction of a biodiversity offset policy resulted in a restricted supply of land and fewer trades ('developments') being completed (Table 2). This highlights one of the intended outcomes of offsetting: that an incentive is created to avoid developing certain types of land (which can be targeted at specific habitat types, in real world policy) in the first place. By no means does this mean development stagnates: as can be seen, trades continued in Game 2 despite the financial constraints placed upon developers by our overly simplistic offset policy. Rather, it allows policymakers to use a market mechanism to encourage developers to leave alone certain high conservation value habitats and develop habitats with lower conservation value [11].

The fact that students requested a change in the rule midway through Game 2 provides an insight into demands made of policymakers by developers in real world offset policies. In particular, the request from student 'developers' to change the value on their cards is analogous to real world developers seeking subsidies or a lifting of certain development constraints in response to biodiversity offset policy. Such requests are seen in practice, and may even result in offset policies taking a number of years to mature [16]. Less productively, a number of the students participating in the games proposed more unscrupulous approaches to facilitating development, such as breaking the rules of the game and sharing information amongst themselves (insider trading). If care is not taken in policy development and implementation, offsetting can lead to problems such as non-compliance, or the creation of various perverse incentives [3; 9].

Finally, we noted that student participants instinctively tended to place offsets adjacent or close to development sites, without being primed to do so (Fig. 3). This reveals a common principle of offsetting, the proximity rule, i. e. offsets should be located as close as possible to the development for which they compensate. The proximity rule is not only considered an element of best practice in offsetting, it also often reflects the preferences of local stakeholders [4].

In conclusion, we consider our biodiversity offset 'trading in a pit market' game to have some potential as both a teaching tool and as a means for gathering data to support development of NNL theory — and encourage other teachers and trainers to experiment with its implementation.

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Джозеф Уильям БУЛЛ[1]
Нильс СТРЕНЖ[2]

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ДЕМОНСТРАЦИЯ РЕЗУЛЬТАТОВ ПРИМЕНЕНИЯ ПОЛИТИКИ КОМПЕНСАЦИИ УЩЕРБА БИОРАЗНООБРАЗИЮ С ИСПОЛЬЗОВАНИЕМ ПРИЕМОВ КЛАССИЧЕСКОЙ ЭКОНОМИЧЕСКОЙ ИГРЫ

[1] доктор философии по экологии,
стипендиат премии Марии Склодовской-Кюри,
Факультет пищевой и ресурсной экономики,
Центр макроэкологии, эволюции и климата,
Университет Копенгагена (Дания)
jwb@ifro.ku.dk

[2] доктор философии в области менеджмента лесов и природы,
профессор, Факультет пищевой и ресурсной экономики,
Центр макроэкологии, эволюции и климата,
Университет Копенгагена (Дания)
nst@ifro.ku.dk

Аннотация

«Компенсация ущерба биоразнообразию» является новым подходом в области охраны природы, с помощью которого можно избавиться от негативного воздействия экономического развития на биоразнообразие. Компенсация ущерба включает в себя количественную оценку прогнозируемых потерь биоразнообразия, связанных с определенным проектом развития, и дальнейшее применение разработчиком мер полной экологической компенсации в других местах, например, в виде восстановления среды обитания. Целью применения метода компенсации ущерба являются достижение чистых нулевых потерь биоразнообразия в целом.

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В данной статье рассматривается эксперимент использования классической экономической игры (‘trading in a pit market’ — торговля в биржевой яме), которая может быть использована в процессе обучения и тренингов. Мы преследовали двоякую цель: во-первых, показать неспециалистам, как работает система компенсации ущерба биоразнообразию; и, во-вторых, разработать новую форму сбора данных для применения этой схемы на практике. В 2016 г. мы провели эксперимент с тремя группами студентов: двумя из Университета Копенгагена в Дании и одной из Шведского сельскохозяйственного университета.

Эксперимент проводился с целью обучения студентов основам компенсации ущерба биоразнообразию. Кроме того, данные, собранные студентами в рамках эксперимента в условиях гипотетического применения и неприменения политики компенсации ущерба на местах, позволили выявить некоторые ключевые принципы, связанные с компенсацией, которые были отмечены в результатах применения реальной мировой политики.

Ключевые слова

Компенсация ущерба биоразнообразию, нулевые потери, биржевая яма.

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