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Wildlife harvesting, conservation and poverty: the economics of olive ridley egg exploitation

ROBERT ADRIAN HOPE*
CLUWRR (Centre for Land Use and Water Resources Research), University of Newcastle, Porter Building, St Thomas' Street, Newcastle, NE1 7RU
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SUMMARY

Eggs of the olive ridley marine turtle (*Lepidochelys olivacea*) have been harvested by generations of Pacific coast communities in Central America for both economic and nutritional reasons. There has been little economic analysis that has identified possible points of improvements for management of the resource. Three egg harvesting projects were studied in Costa Rica and Nicaragua. Field research using semi-structured interviews with stakeholders and key informants were undertaken in June and July 2000. Market price data were collected from harvesters, points of sale and government records. Spread price analysis suggested that more flexible seasonal and regional pricing policies might increase egg profits. Contested property rights have weakened incentives to manage the species as an asset rather than an open access resource. Transaction costs have reduced community efficiency in egg marketing. Community egg marketing cartels with authorized urban selling points are recommended to improve resource management, appropriate a higher egg profit margin and clarify the harvesting origin of eggs for consumers.

Keywords: wildlife conservation, natural resource management, olive ridley, rural development

INTRODUCTION

Conservation management of the olive ridley (*Lepidochelys olivacea)* egg harvest along the Pacific coast of Central America has generated considerable debate over the last 30 years (Cornelius & Robinson 1985; Ballestero *et al.* 1998; Campbell 1998; Chaves-Quiros 1998; Valverde *et al.* 1998; Valverde 1999; Araúz 2000). The olive ridley conservation literature strongly focuses on the biological aspects of the species (Cornelius & Robinson 1985; Cornelius *et al.* 1991; Araúz & Mo 1994; Eckert 1995; Eckrich & Owens 1995; Ross 1995; Castro *et al.* 1997; Heppell 1997; Valverde *et al.* 1998; MARENA [Ministerio de Recursos Naturales/Nicaraguan Natural Resource Ministry] 1999; Russell *et al.* 1999). There is limited reference to the reasons why the harvesters collect the eggs or how the resource is managed from extraction to sale or consumption (Araúz-Almengor *et al.* 1993*;* COMAREN [Municipal Environment and Natural Resources Commission] 1999; Morera 2000*a*). It is argued here that two of the critical reasons for egg harvesting are the values of the eggs as both nutritional and economic goods. These goods are of particular value to the harvesting communities, which are all characterized by varying degrees of poverty and food insecurity. This paper explores the management of three olive ridley egg harvesting regimes in Nicaragua and Costa Rica from an economic perspective and compares the findings with one nesting beach in Costa Rica that has not been subject to any human harvesting impacts.

In recent decades, challenges have been made to traditional wildlife resource management, largely derived from research in Africa (Burgess 1989; Barbier *et al.* 1990; Bonner 1993) but with wider global significance (Swanson 1993; Freeman & Kreuter 1994; Lutz & Caldecott 1996; Hutton & Dickson 2000). The underlying premise of this pattern of wildlife management was a preservation approach, management remote from the resource location, and identification of local harvesters as the primary culprits in overexploitation. This paradigm of wildlife conservation was rooted in the power relations that existed ostensibly in countries in Africa prior to independence in the 1960s, but which can be argued to be as applicable in Asian and Latin American countries due to geo-political and market forces (Perez-Brignoli 1989; Bonner 1993; Hutton & Dickson 2000). Substantial and wide-ranging evidence indicates that poor people's livelihood strategies are significantly dependent on their access and entitlements to the natural resource base (Sen 1981; UNCED [United Nations Conference on Environment and Development] 1992; Carney 1998; World Bank 2000).

Hulme and Murphree (1999) illustrate a new approach, which is characterized by neo-liberal use of resources, community or local management, and integration of conservation with development. This 'new conservation' is no universal panacea for the management of contested and scarce wildlife resources, but suggests a more equitable framework that may lead to more efficient and sustainable wildlife resource management. A key failing of this approach, to date, is the institutional failure of projects, where a lack of local-level capacity has weakened the distribution of benefits (Lutz & Caldecott 1996). Swanson (1991) explains such

* Correspondence: Mr Robert Hope Tel: +44 191 222 7116 (office) e-mail: robert.hope@ncl.ac.uk

weaknesses as being due to the resource harvesters failing to collect a proportionate share of the value placed on the resource whilst having to bear all the costs of the resource management. For example, in the case of olive ridley eggs, it will be argued that the harvesting communities invest significant amounts of time, effort and resources in cleaning, patrolling and isolating the rookeries (nesting beaches) from light, predators and humans, yet receive a disproportionately small share of the true market value of the egg sales. It is argued that improvement in wildlife management must take account of the human response to different conservation policy regimes in order to implement measures that mutually reinforce wildlife conservation and human development.

Before describing the egg harvesting projects, I will briefly illustrate the salient aspects of olive ridley biology, species status and justification for its harvest.

OLIVE RIDLEY BIOLOGY, HARVESTING JUSTIFICATION AND SPECIES THREATS

The olive ridley is considered the most abundant of the world's marine turtles (Ross 1995: p. 181), nesting both in a solitary fashion and in a synchronized flotilla known as an '*arribada*' (Cornelius & Robinson 1985). Arribadas vary in magnitude across seasons, regions and months. Arribadas may occur over 2–10 days and can lead to 10 000s of turtles on a narrow beach area. Nine arribada beaches are thought to occur globally, namely in Costa Rica, Nicaragua, Panama, Mexico, Surinam and India (National Marine Fisheries Services/US Fish And Wildlife Service 1996). The Pacific coast rookeries of Río Escalante-Chacocente and Playa La Flor in Nicaragua and Playa Nancite and Ostional in Costa Rica represent a significant proportion of the Eastern Tropical Pacific (ETP) populations (Eckert 1995; Fig. 1). Apart from Nancite, olive ridley eggs from the three other beaches have been harvested by generations of rural communities for both nutritional and economic reasons. Nancite may be characterized as a control beach due to regular research since the 1970s and no human harvesting impacts (Eckrich & Owens 1995; Valverde *et al.* 1998). These four rookeries are the basis for discussion in this paper (Table 1).

Arribadas generally follow a monthly schedule during the wet season (June–January) in Nicaragua and Costa Rica. The reproductive cycle generally occurs on an annual basis (Eckert 1995) with intervals of 2 and 3 years also noted (Dutro 1994). Nancite studies have suggested an average of two clutches per breeding season (Plotkin *et al.* 1993), with an average clutch size of 105–120 eggs (Pritchard & Mortimer 1999). Monthly temperature, moisture, egg-density, environmental and physical fluctuations will impact on the hatching success rates. Hatching occurs at between 45–65 days (Dutro 1994; Eckert 1995).

Eckrich and Owens (1995) recorded a significant difference between the success rates of hatchlings from solitary nestings compared to arribadas at Nancite (8% and 51% respectively). This natural defence mechanism to predation results in the nesting beach becoming saturated with eggs. Within the peak nesting months, arribadas may reoccur before hatching of the eggs lain previously, which results in re-exhumation of nests and egg losses. Costa Rican estimates of hatching success rates have indicated that the non-harvesting beach, Nancite, had a lower hatching success rate than the human-exploited beach, Ostional (Cornelius *et al.*

Table 1 Details of the four olive ridley rookeries (* combined estimate for both rookeries). N/A = not applicable.

Variable	*Chacocente*	*La Flor*	*Nancite*	*Ostional*
Location (province)	11° north, 88° west (Carazo)	11° north, 87° west (Rivas)	11° north, 86° west (Guanacaste)	10° north, 85° west (Guanacaste)
Beach length (m)	1545	1600	1050	7000
Egg harvesting by communities	Yes	Yes	No	Yes
Arribadas per year (range/years)	5–7 (1993–1999)	5–7 (1993–1999)	No data	4–12 (1982–1999)
Mean arribada size	66 885* (1993–1999)	66 885* (1993–1999)	37 960 (1980–1996)	635 092 (1982–1999)
Community egg marketing association	No	No	N/A	Yes
Total people with egg harvesting rights (1999)	5754	2618	N/A	215
Average monthly per caput income (US$), June 2000	38–63	38–63	N/A	70–100
Management authority	MARENA	MARENA	MINAE	MINAE/ INCOPESCA

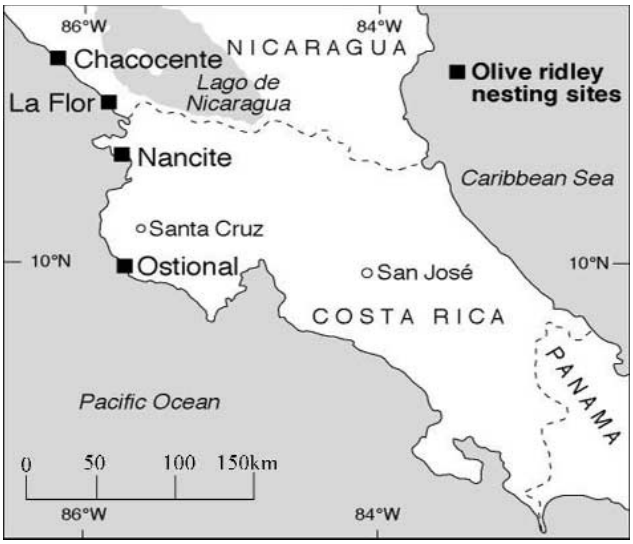

Figure 1 Location of main olive ridley nesting beaches on the Pacific coasts of Costa Rica and Nicaragua

1991; Araúz & Mo 1994). The destruction of previously laid eggs by subsequent nesting females and the negative impact for hatching success has formed the scientific basis for permitting a managed harvest of an arribada (Cornelius & Robinson 1985). The scientific justification for the sustainability of egg harvesting is a stable adult population and sufficient egg protection to allow recruitment from hatchlings (Campbell 1998). Review of egg harvesting impacts at Ostional over 11 years concluded that it was not clear whether the adult and subadult populations were stable due to the weakness of the counting methodology (Ballestero *et al.* 1998; see Table 2).

A significant time lag before sexual maturity, estimated at 7–9 years (Dutro 1994) and 10–30 years (Bolten & Bjorndal 1993), hinders any stability prognosis because of the limited and variable data sets compiled. Heppell (1997) highlights the importance of subadult and adult annual survival over egg and hatchling survival due to the fact that the reproductive value of eggs and hatchlings is generally much lower than that of large juveniles, subadults or adults.

Interaction of olive ridleys with industrial fisheries is believed to be critical in determining their population status and survival in the ETP (Araúz 2000). Araúz-Almengor *et al.* (1993) estimated 60 000 marine turtles were captured in shrimp nets on the Pacific coast of Central America in 1993, the majority being olive ridleys. Araúz *et al.* (1997) estimate that 90% of incidental capture in the shrimp fleet of Costa Rica are olive ridleys, with a mortality rate of 37%, resulting in an estimated annual marine turtle catch along the Costa Rican Pacific coast of 15 631. In the Economic Exclusion Zone of Costa Rica, olive ridleys are the second most abundant species captured by long-lines (monofilament lines 19–24 km in length with hooks every 5–10 m). Ninety-nine per cent of the olive ridleys had the hook removed and were released alive. Post-hooking mortality of Mediterranean

Table 2 Arribada and nest-hatching estimation methodologies. ELF = egg laying females; TT = total turtles; MNB = main nesting beach; UCR = Universidad de Costa Rica.

Methodology	*Rookery*			
	Río Escalante-	*Playa La Flor*	*Nancite*	*Ostional*
Arribada counting methodology	100 m transects; all ELFs marked by paint; counting only 1 July–31 January	100 m transects; all ELFs marked by paint; counting only 1 July–31 January	Beach divided into 100 m transects; random quadrants (10 m × 10 m) selected by width of transect; counts made every 2 hrs	Various methods used: majority of historical data based on 3 × 10 m × 15 m transects on the MNB (880 m of 7000 m), extrapolated to estimate total. In 1998, 'flujo' method of 'eye' counts of emerging ridleys on entire foreshore on hourly basis, no account of ELF versus TT (no data released)
Nest-hatching and hatchling counting methodology	Random, samples of nests marked every 50 m; cages placed prior to hatching; hatchlings counted, nest exhumed and dead hatchlings, dead eggs, and causes of death noted	Random, samples of nests marked every 50 m; cages placed prior to hatching; hatchlings counted, nest exhumed and dead hatchlings, dead eggs, and causes of death noted	Random, stratified samples of beach transects determine number of hatchlings and exhumed nests estimate cause of death of hatchlings and egg fertility levels	Every 50 m transect, 5 nests are randomly selected from 1 m of the high, mid and lower beach area. Hatchlings are counted; nests exhumed and monitored; results are extrapolated. The current UCR biologist has stated that this area of research is of priority (Cordero 2000)
Trial of Valverde & Gates (1999) 'Instantaneous Count' method	No	No	Yes; issue of applicability for arribadas < 1000 nesting ridleys	Yes; Russell *et al.* (1999) published analysis highlighting spatial distribution of arribada inter and intra-monthly, plus the variation between ELF and TT

loggerhead turtles (*Caretta caretta*) was 30% (Araúz 2000). Ramifications of prolonged and high by-catch mortality are highlighted by a study of the Playa Grande, leatherback marine turtle (*Dermochelys coricaea*) rookery in Costa Rica. Annual mortality during the 1990s by gillnet and long-line fisheries was 1500 females; the Pacific population is now believed to be on the verge of extinction (Spotila *et al*. 2000).

In sum, biological research suggests that by-catch impacts are more significant to the population stability of the olive ridley than appropriately managed egg harvesting programmes. Yet rural egg harvesting communities face a number of institutional challenges to their rights to harvest the egg resource, primarily based on the population stability of the olive ridley (Hope 2000). This paper argues that tangible opportunities exist to both manage the egg resource more effectively and alleviate poverty in harvesting communities. The following section will now briefly describe the relevant aspects of the harvesting projects.

Description of egg harvesting projects

In Nicaragua, MARENA is the competent authority for marine turtle conservation and management. The National System of Protected Areas (Dirección de Operacciones del Sistema Nacional de Areas Protegidas [DOSINAP]) is the operational directive within the General Directorate of Protected Areas (Dirección General de Areas Protegidas [DGAP]). DOSINAP does not have authority over fishing activities outside refuge boundaries or over international conservation conventions. Following the 1980 olive ridley protection and monitoring campaign, MARENA initiated subsistence egg harvesting programmes at La Flor and Chacocente in 1993 (MARENA 1999). Egg harvesting is complicated by MARENA's authorization of a controlled and managed harvest of the arribada eggs at Chacocente and La Flor whilst the sale of marine turtle eggs is illegal in Nicaragua. Egg harvesting is permitted during the period 1 February–30 June, due to high sand temperatures and minimal nestings (Duarte 2000); during the remainder of the year there is a ban (*veda*) to public (open) access harvesting. No support (credit, infrastructure, capacity-building) is provided to facilitate the legal community egg harvesting. Cocibolca (an environmental non-governmental organization [NGO] at La Flor) and government institutions (including USAID [United States Agency for International Development]) have conducted environmental awareness programmes with some of the communities (Eckert 1995). Contested land rights due to competing state, communal, further complicate harvesting rights and private claims ratified by official documentation from the Samoza, Sandinista and Chamorro administrations.

Chacocente was declared a Wildlife Refuge in 1983 (Decrees Nos. 1320, 213, 1294, 187 and Law No. 217, Government of Nicaragua) but it was in 1992 that MARENA took direct control over the refuge supported by the army. Previously, the beach was under exclusive military control with no access permitted. Five of the 17 communities with egg harvesting rights are within the refuge boundaries (Grijalva 2000). The communities represent the poorest of Santa Teresa province with livelihood strategies dependent on basic grain crops, fuelwood collection and citrus cultivation (FUNDENIC-SOS [Fundacion Nicaragüense para el Desarrollo Sostenible] 1999). MARENA and the army in monthly meetings with community representation manage egg harvesting. The communities close to the colony believe their use rights should take precedence over more distant claims (L. Cardenas, personal communication 2000). The communities have no storage facilities or communal marketing procedures. Individual families sell or consume the eggs, 2–3 dozen per family in 1999/2000 (Grijalva 2000), subject to market prices, alternative food sources and variable egg allocations. The distribution of eggs is subject to arribada size and based on a community rotational basis. Egg price spread (seasonal and regional; Table 3) is significant and aggravated by multiple suppliers selling to a limited network of intermediaries and the confusing legal situation. A simple supply-demand function determines higher prices during the low nesting period and vice versa. COMAREN (1999) proposed the economic feasibility of community-managed egg distribution given the significant profits being lost to intermediaries.

La Flor was declared a Wildlife Refuge (May 1996) as part of the General Environmental Law No. 216 (Government of Nicaragua). Limited land potential, unemployment and poor harvests (grains, citrus and fish) have worsened the livelihood opportunities of the communities (FUNDENIC-SOS 1999). Eight neighbouring communities (598 families) receive a

Table 3 Price spread analysis of olive ridley egg harvesting projects. Legal and illegal price spreads refer to the seasonal price range from the lowest price received by the harvesters divided by the highest price paid by the final consumer. Regional spread refers to the range across geographic selling points (generally, harvesting community to major city). Egg prices: Ostional, Costa Rica (per 200 unit bag), Nicaragua (per dozen). US$ 1 ≈ 12 Nicaraguan Córdobas (Cs); US$ 1 ≈ 300 Costa Rican Colones (Cls), June 2000. N/A = not applicable.

Rookery	*Legal harvesting period (1 February– 30 June)*	*Illegal harvesting period (1 July–31 January)*	*Regional spread*
Chacocente	33% (= 5/15 Cs)	32% (= 8/25 Cs)	Estimated at 674 946 Cs (COMAREN 1999)
La Flor	37.5% (= 22.5/60 Cs)	10% (= 8/80 Cs)	No data
Ostional	N/A	N/A	16.5% (= 16.5/100 Cls)

quota from the egg harvest. During the veda, military armed personnel, MARENA, community representatives and Cocibolca monitor the beach, though illegal harvesting represents an estimated 4.37% of total nests laid in 1999/2000. This compares to the 4.13% of eggs legally harvested during the non-veda period (Duarte 2000).

Community egg marketing and management reflects the situation at Chacocente. However, restaurants in the tourist village of San Juan del Sur (*c.* 23 km north) provide convenient market access for the eggs and good transportation on to Managua. The restaurateurs stated that demand was high for the eggs as they were a popular Nicaraguan delicacy and possessed aphrodisiacal properties (as also identified by Costa Rican men; Araúz-Almengor *et al.* 1993). The restaurateurs reported that they could purchase eggs more cheaply if a large arribada occurred. Contested land tenure at La Flor creates additional barriers to developing an equitable and agreed conservation environment (L. Canda, personal communication 2000).

In Costa Rica, MINAE (Ministerio de Ambiente y Energia/ Environment Ministry) is responsible for research into and management and conservation of the olive ridley, with INCOPESCA (Instituto Costarricense de Pesca y Acuacultura/ Costa Rican Fisheries and Aquaculture Institute) managing the national egg commerce. Ostional's community has been the focus of heated debate in Costa Rica due to its anomalous status as a wildlife harvester, which is intensified by the strong climate of marine turtle preservation that exists in Costa Rica for both scientific and ecotourism concerns (Honey 1999; Valverde 1999).

Nancite is more representative of Costa Rican wildlife resource management as it is protected in the Santa Rosa national park. Valverde *et al*. (1998) recorded a steady decline in arribada size at Nancite from 1980–1996, which was attributed to a range of natural (rookery exchange, poor hatching, ENSO [El-Niño Southern Oscillation] events) and human impacts (by-catch).

Wildlife Conservation Law 6919 (Government of Costa Rica) established the Ostional Wildlife Refuge (RVSO) in 1983. Commercialization Law 17802 (Government of Costa Rica) in 1987 permitted legal harvesting subject to approval by MINAE, with INCOPESCA responsible for egg commerce from 1984 (Campbell 1998). In 1984, a community development association (Asociación de Desarrollo Integrado de Ostional [ADIO]*)* was legally formed to manage the egg harvest, distribute the benefits amongst the community and fund a resident biologist (Morera 2000*c*). Community size is estimated at 500 (105 families), of whom 215 are members of the ADIO (Morera 2000*b*). In 1980, *La Nación* (6 March 1980, p. B12) reported Ostional's population to be roughly 400 with 30% of households generating their income from egg sales. Campbell (1998) reported that 70% of households were dependent on egg harvesting. The Instituto Tecnológico de Costa Rica/Colegio Cientifico Costarricense (ITRC/CCC 2000) reported a fall in direct dependency to 32% of households generating their income through egg commerce alone, 56% of households were pursuing a 'mixed' strategy (egg commerce, fishing, agriculture, handicrafts), and 12% of households derived their income from construction and other activities. Livelihood opportunities are dependent on land ownership, physical capital and ADIO membership. ADIO membership is no longer officially automatic for family offspring and is a cause of conflict (Campbell 1998); one family in the village has six ADIO members. Ecotourism has been considered as a possible non-use development strategy, but research has suggested that without external intervention, opportunities are limited and may conflict with the harvesting project (Campbell 1999).

Egg harvesting and marketing is sophisticated in comparison with the Nicaraguan projects. Once the required permission has been granted from MINAE, ADIO coordinates the egg harvest, cleaning, packaging and distribution to all the major cities in Costa Rica. Wholesalers are contacted to estimate demand, though the price per 200-unit bag has been determined by an annual increment of 200 Cls (US$ 1 = 300 Costa Rican Cls, June 2000) since 1996. This undercuts hens' eggs and the rate of inflation (Hope 2000). Egg demand was reported to be always higher than supply. Public sale is generally through bars (cantinas), restaurants (Araúz-Almengor *et al.* 1993) and, recently, five Coopecompro (Guanacaste Province) supermarkets. ADIO members receive 70% of the revenue, 30% goes to community projects, administrative costs and hardship grants. The state appropriates 40% of the community revenue (Morera 2000*a*). Egg sales have partly or fully financed the construction of the school, biological station, two river footbridges, the schoolteacher's house, health centre and warehouse (Morera 2000*b*).

An economic perspective on egg harvesting

People harvest olive ridley eggs to make money and to eat a nutritional food. There is little investment in finding the eggs as the arribada phenomenon provides a bounty of eggs in a frequently predefined area, the nesting beach. Protecting nesting females and hatchlings represents an investment in future harvests. If the olive ridley is considered a valuable resource it may be worthwhile restricting harvesting activities to maintain a sustainable flow of economic and nutritional goods. When communities have no agreed harvesting rights and are aware that by-catch diminishes the resource beyond their control, the communities' time preference in terms of harvesting the eggs will encourage a short-term, high-level harvest. This rational economic behaviour is described as 'optimal extinction' (Clark 1973). Optimal extinction may occur when:

(1) There is a high resource price to harvesting cost;
(2) There is a high discount rate (short-term time preference) for harvesters relative to the growth rate of the resource; and,
(3) Property rights are not allocated efficiently or are contested.

Condition (1) suggests that excessive economic rent (surplus profit) from egg harvesting will provide an incentive toward overharvesting the eggs. Rent is defined as the difference between the total value of selling a commodity to the costs of supplying it (Barbier *et al.* 1990). If large rents are available from egg harvesting then there will be an incentive for many individuals to undertake this activity, or for an expansion of the current harvesting activities.

If harvesters are poor, as in the case of Central American harvesting communities, poaching activities become cheap relative to the price of eggs, leading to sizeable rents. If egg prices are buoyant because of strong final demand for eggs in markets, or it is a readily substitutable food source, poaching and harvesting activities will be increased. However, fulfilment of condition (1) is not sufficient to cause overexploitation of the olive ridley egg resource. In fact, it provides strong incentives for a sustainable management of the egg resource (current and future populations) provided that the legitimate harvesters can capture a sufficient proportion of the rents that would otherwise go to poachers or intermediaries. It is thus not the existence of rents that determines the incentives for overexploitation but who captures those rents.

Condition (2) is closely related to condition (3) in the context of the olive ridley egg harvesting projects. This is due to two reasons. Firstly, the actual growth rate, recruitment rate and longevity of the olive ridley are yet to be accurately determined. This allows no meaningful analysis of the real price of eggs over time with the species growth rate. An important corollary of the lack of this biological data is the extreme difficulty in providing a reliable estimate for a sustainable egg-harvesting rate. Consequentially, there has been extensive debate between the harvesting communities and the state management authorities, which determine and authorize the harvesting level (Valverde 1999). Secondly, this debate has focused on who has the legitimate rights to harvest and manage the resource.

Condition (3) has relevance both in terms of the initial distribution of the property rights and the transaction costs (encompassing search, negotiation and enforcement costs) that occur in reaching an agreement on harvesting levels. In all three harvesting rookeries, the property rights are contested but are enforced by the state.

The optimal extinction model offers guidance in terms of how conservation policy might better serve both the sustainability of the terrestrial stage of the olive ridley reproduction cycle and the human development of the harvesting communities. Following this model, the objectives of this research were to investigate:

- Rent dissipation in the supply chain;
- Egg pricing policies; and,
- Institutional egg marketing structure.

METHODS

Research involved two phases. Firstly, the most significant olive ridley rookeries in the ETP were identified and available data on the economic management of the egg harvesting projects analysed. Secondly, a field trip to Costa Rica and Nicaragua was made between 8 June and 13 July 2000 to collect primary data on the harvesting projects, conduct semi-structured interviews and refer to nationally available literature.

Semi-structured interviews were conducted with:

- National and regional environmental authorities: Ministry of Natural Resources (MARENA: Managua, Carazo and Rivas) in Nicaragua and the Ministry of Environment and Energy (MINAE: Nicoya) in Costa Rica;
- Environmental NGOs with significant experience of the egg harvesting projects: Fundación Cocibolca (La Flor) and NICAMBIENTA*L* (Chacocente) in Nicaragua, and the Sea Turtle Restoration Project (STRP) in Costa Rica;
- Harvesting communities: in Nicaragua, El Ostional (La Flor) and the Santa Teresa Municipal Environment and Natural Resources Commission (COMAREN), representing Chacocente, and in Costa Rica, the Ostional Integrated Development Association (ADIO);
- University biological departments: Costa Rican biologists from the Universidad Nacional (UNA) and Universidad de Costa Rica (UCR).

In addition, other relevant organizations were interviewed: the Costa Rican Fisheries Institute (INCOPESCA), the Nicoya Peninsula Agricultural Development Project (PRODAPEN), Guanacaste, Costa Rica, and the International Agricultural and Livestock School (EIAG) Rivas, Nicaragua. Relevant economic data that were included in government ministry reports were collated and cross-referenced with my own findings.

Purposive random sampling of egg harvesters and traders was conducted at La Flor, Ostional and Santa Teresa (for Chacocente). Interviews were semi-structured focusing on the institutional and policy environment, harvesting organization, egg marketing and the significance of the egg resource within individuals' livelihood strategies. Key informants were interviewed from MARENA, MINAE, INCOPESCA, the relevant environmental NGOs, marine biologists (Costa Rica only) and community development organizations linked to the harvesting schemes (COMAREN and ADIO). All interviews were conducted in Spanish by the author.

Egg price data were collated from markets and restaurants in San Juan del Sur, El Ostional in Nicaragua, and Liberia and San José in Costa Rica; government reports provided further marketing data.

RESULTS

Significant rent dissipation occurred in all three egg-harvesting projects. The situation was particularly acute in Nicaragua, where socio-economic pressure was greater and no central marketing association coordinated the egg

marketing activity. An effective monopsony (one buyer, many sellers) characterized the Nicaraguan market in contrast to the monopoly (one seller, many buyers) situation in Costa Rica. The contrasting market conditions resulted in significantly differing marketing opportunities that determined differing harvesting strategies. Limited marketing opportunities and rent capture encouraged resource exploitation in Nicaragua; more effective resource management and higher rent capture encouraged resource conservation in Costa Rica.

Conservation policy in Nicaragua encouraged the overexploitation of olive ridley eggs as the trade was driven underground by the legal paradox of permitted egg harvesting but prohibited egg selling. This environment had fragmented potential sellers into weak individual units that had been exploited by more powerful buying elites. The price spreads (seasonal and regional) had further encouraged illegal poaching because of the significant revenue that could be generated in the face of high unemployment and limited livelihood opportunities. If a Nicaraguan family wished to sell their eggs directly it would have involved individually incurred transportation, opportunity and negotiation costs. The individual decision to sell or consume the eggs was moderated by market prices, food security and the variable allocation of eggs. Individual or family risk and uncertainty were not pooled with the community and therefore the costs were considerably higher (Pearce *et al.* 1989). No storage infrastructure, community transport or institutional capacity facilitated a more integrated and coherent process of managing the egg resource from the initial allocation to the communities to public consumption. Intermediaries not the communities appropriated egg revenues, thus encouraging a short-term time preference and overexploitation of the egg resource.

In contrast, the institutional marketing structure that operated at Ostional facilitated a controlled and relatively efficient distribution of the harvested eggs. Significant community benefits have occurred with the ADIO's coordination of the harvest (Campbell 1998; Morera 2000*b*). Whilst the ADIO membership has been restricted below the level of community population growth, tensions had arisen due to legal bans on building work, road maintenance, lighting and the security of the ADIO's legal tenure. The harvest was briefly banned in August 2000 due to 'lack of planning in the exploitation of the eggs' though later reinstated by the Environment Minister (R. Araúz, personal communication 2000). Shared community benefits and risk management of the egg resource have helped develop a community strategy to maximize egg revenue whilst facilitating the reproductive success of the olive ridley. Weaknesses in pricing the eggs were identified in the significant seasonal price spread, which suggests the community might have captured a greater proportion of the revenue than it had to date.

DISCUSSION

Egg rent dissipation, pricing policy and institutional marketing structure are logically linked to the sustainable management of the olive ridley resource and community development. Efficient economic management of olive ridley egg harvesting may not ensure species sustainability alone, though techniques to facilitate improvements in rent capture may contribute to this end.

Wildlife conservation management that does not adequately address the interaction of human dependency on its livelihood resource base is likely to create distorted and ineffective strategies for sustainable wildlife conservation and human development. Poverty accentuates the interaction and relationship between humans and natural resources, which offers opportunities and constraints to wildlife conservation. Evidence (Swanson 1993; Lutz & Caldecott 1996; Hulme & Murphree 2000; Hutton & Dickson 2000) indicates that this interaction can be mutually beneficial given a holistic understanding, equitable distribution and agreed management of the wildlife resource.

The human relationship with the nesting phase of olive ridleys may be characterized by positive, negative or neutral stewardship. The stewardship strategy is determined by the livelihood constraints faced by the neighbouring human population. Extreme poverty driven by local socio-economic conditions with limited benefits from the wildlife resource determines a negative strategy of overexploitation. This strategy may be modified by the distribution of the benefits accruing to the communities from a more benign use regime. Non-use regimes, such as ecotourism, are problematic due to conflicts with the harvesting regime, negative impacts on the nesting sequence (artificial light, in particular) and limited interest or development in any of the rookeries. Egg price spreads indicate in all egg harvesting projects that potential revenue is being lost. Further research may indicate that greater rent capture and more efficient economic egg management could reduce egg harvesting, particularly in the current monopoly, high-demand situation that Ostional reflects. The neutral stewardship strategy at Nancite has resulted in declining hatching success rates over time (Valverde *et al.* 1998).

Partnership conservation management characterizes the current egg harvesting projects with externally enforced compliance. This hybrid regime neither has the preservation restrictions of national patrimony nor the collective choice arrangements of community management. Ostrom (1990, p. 99) argues that when resource appropriators (egg harvesters) design their own operational rules, enforced by themselves, using graduated sanctions that define who has use rights, the commitment and monitoring problem of self-governance will be solved in an interrelated manner. Rules that produce higher joint benefits with self-enforced monitoring will encourage individuals to commit to such a regime. At Ostional, there are clear indications of local design of operational rules (by the ADIO), sanctions (fines and membership suspension), monitoring of the resource (beach patrols, cleaning, etc.), and the higher joint benefits (school, bridges, etc.) accruing to all the community. In contrast, Chacocente and La Flor differ most significantly in the lack of joint

benefits accruing to the communities. This may be explained by the higher human:egg dependency ratio, the socio-economic conditions and the geographical fragmentation of communities with use rights. Ostrom's (1990, p. 57) characterization of institutional failure at self-governance by 'extreme rent dissipation, unresolved disagreements leading to physical violence, or resource deterioration' is corroborated by this research with particular emphasis on the importance of efficient management of the egg revenue stream. Disagreements and violence have also been recorded at Ostional (Valverde 1999) and in Nicaragua.

Identifying the community as the culprit in resource exploitation offers a limited analysis of the potential benefits of integrating resource conservation and human development. Managed egg harvesting still appears to benefit the sustainability of the olive ridley and communities that facilitate this process also benefit when given suitable incentives by the conservation management regime. Strategies to improve the management structure should be pursued, rather than focusing on the inherent difficulties of such a complex process. Clarifying tenure and use rights, capacity building and improved egg marketing may contribute to improved conservation management. Coase (1960) demonstrated that bargaining between parties might achieve efficient outcomes dependent on the initial distribution of property rights. The costs of state enforcement, monitoring and legal disputes in all the harvesting projects suggest inefficient wildlife management.

Contested property rights reduce community investment in resource management (Ostrom 1990; North 1995). Legal clarification of egg harvesting could reduce the poaching impact in Nicaragua and reinforce Ostional beach monitoring in Costa Rica by creating community incentives to invest in the olive ridley population and enforce sustainable harvest levels. In Nicaragua, evidence suggests that a reduced and managed flow of eggs would generate greater rents for the legitimate harvesters. Thus, there is an incentive to create an enforceable egg cartel to maximize revenues. Less certain is the Ostional egg demand function due to the fixed pricing mechanism. The demand function may be inelastic but equally the price below hens' eggs may suggest that olive ridley eggs are an 'inferior' good. Hens' eggs would be substituted if consumer income levels rose. If the Ostional eggs were a 'normal' good the reverse would apply. Further research must establish these elasticities in order to implement efficient pricing levels.

The relative success that the ADIO has enjoyed to date indicates that a similar marketing mechanism may be appropriate in Nicaragua. However, the significant regional price spread that occurs in Costa Rica suggests that distribution management and pricing policy are sub-optimal. This fact is likely to be related to the sensitivity of environmental issues within Costa Rica and the confusion amongst potential egg consumers of the authenticity of the marine turtle species (Araúz-Almengor *et al.* 1993). Labelling the eggs individually or in smaller unit bags that correspond to consumer buying preferences may overcome some of this uncertainty. Two issues arise if this objective is to be achieved: establishing more efficient regional distribution outlets and gaining access to sufficient credit to develop marketing activities. An improved distribution policy would include greater flexibility in releasing the supply of eggs (for example, refrigeration storage and transport), establishing more equitable terms of trade with wholesalers and improving the access road to Ostional.

It would be appropriate to conduct pricing trials on both a seasonal and regional basis to determine demand profiles on a temporal and geographical basis to optimize marketing activity. Trial auction pricing with wholesalers could identify more appropriate pricing levels particularly with a 'price floor' facilitated by egg refrigeration.

Community egg marketing cartels with authorized urban selling points would offer a number of resource and community benefits:

- Legal eggs would be differentiated from illegal sources;
- Eggs could be certified as originating from a stable and well-managed stock;
- Increased rents would provide incentives for community monitoring and enforcement, provided that the majority of the revenue is appropriated by the communities; and,
- More efficient rent appropriation could facilitate community development.

This positive feedback is a critical component of the egg marketing cartels. The current high level of Nicaraguan poaching may be partly explained by rent erosion, weak conservation management and negative feedback loops.

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