

Sustained by Snakes? Seasonal Livelihood Strategies and Resource Conservation by Tonle Sap Fishers in Cambodia

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Abstract This paper situates concerns for conservation of aquatic snakes and livelihood sustainability in Cambodia within a social–ecological systems context and thereby presents a challenge to conventional species-based conservation programmes. Fishing for low-value water snakes has become a widespread activity within the floating communities of Tonle Sap Lake in the last 20 years in response to new market opportunities, provided primarily by a crocodile farming industry. The scale and intensity of this new form of exploitation and reports of declines in catch per fisher have highlighted this activity as a conservation concern, yet its role within local livelihood strategies was previously unknown. We show that it is of increasing importance to the less well-off, and is linked to higher incomes within this group, where it potentially reduces their vulnerability to fluctuations and declines in fish catches. It is particularly important as a means to smooth seasonality of incomes in this flood pulse-driven social–ecological system. We argue that shifts between snake-hunting and fishing, as a market-driven adaptive livelihood strategy by

the poor, may be more compatible with wider ecosystem conservation and development goals than alternatives such as increased fishing effort or converting floodplain habitats for seasonal agriculture.

Keywords Adaptive management · Vulnerability · Social–ecological systems · Hunting · Poverty · Aquatic resources · Cambodia

Introduction

The management of hunting, gathering or fishing activities has been guided by the concept of sustainable exploitation rates. Models to estimate these rates and the management targets for sustainable off-take or harvest have typically been applied to populations of single species, assumed to be living in stable environments and subject to targeted exploitation that can be limited by some form of directed control, such as bag limits or quotas, seasonal bans or restrictions on where the species can be exploited (Milner-Gulland and Mace 1998; Reynolds and Peres 2006). By focusing narrowly on the species and activity in question, these models fail to account for how exploitation of that species fits within both the ecosystem and the livelihood system. Conservation and resource management measures based on these kinds of assessments risk being unachievable and irrelevant in a context where the resource users have complex livelihoods that include a variety of agricultural, natural resource exploitation and non-natural resource-based activities, and where the natural resources are harvested from diverse and seasonally and spatially dynamic ecosystems. This is especially the case in the developing countries of the tropics, where small-scale fisheries and local wildlife hunting directly support large

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numbers of the rural poor (Milner-Gulland and Mace 1998; Pauly 1997).

This paper uses a case study approach to demonstrate the importance of viewing sustainability of resource use activities at the level of ecosystems and livelihoods, rather than that of single-population and single activities. We look at the uptake of snake hunting by fishers living on the Tonle Sap Lake in Cambodia. Tonle Sap is a pulsing system whereby the annual inundation of the floodplain drives productivity, providing an array of seasonally available resources (Junk *et al.* 1989; Kummu *et al.* 2006). Each year as the Mekong River rises, the Tonle Sap River reverses direction, flooding a massive expanse of grassland, forest and agricultural land surrounding the Tonle Sap Lake. This flood pulse shapes the entire social–ecological system by determining the livelihoods patterns that emerge. In such a seasonal system, both wildlife and people are well adapted to the effects of the changing water level, including changes in food supply and type, migration patterns, and habitat alterations. Whether this inbuilt adaptability can confer some form of resilience to change is, however, unknown. Nonetheless, the kind of management intervention required needs careful consideration, given that many conventional methods do not take account of the resource conservation strategies potentially already in place through the adaptive capacity of resource-users (Berkes and Turner 2006).

Tonle Sap Lake is one of Cambodia's most important natural resources with well over one million people directly depending on its aquatic resources (Bonheur and Lane 2002; Hap *et al.* 2006). The ecosystem has, however, been severely degraded and over-exploited and strong declines in fish catch per unit effort and a loss of many fish species have been reported (Bonheur and Lane 2002; Lim *et al.* 1999). Wildlife hunting is also prevalent throughout the region, and in recent years water snakes have become a highly exploited resource (Brooks *et al.* 2007; Stuart *et al.* 2000). Around seven million snakes are captured annually, representing the world's largest snake hunting operation and severe declines in catch per hunter have been reported based on the recall of hunters (Brooks *et al.* 2007). It is therefore feared that over-exploitation will threaten the long-term well-being of the people who depend upon snakes.

Although the scale of this activity has been documented, little is known about the importance of snakes to local resource users. We aim to demonstrate how and why snake hunting came about, through understanding recent changes that have occurred on Tonle Sap from the perspective of the resource users. We assess the importance of snake hunting to the communities of fishers by showing how it fits into seasonal activity profiles, and through its economic importance to livelihoods. Understanding not only how important an activity is, but when and to whom it is most

important, will help to develop appropriate management recommendations that strengthen overall livelihood and ecosystem sustainability. We adopt a wider view of the threats that cause resource declines, rather than focusing only on the direct threat of overexploitation. This case study will therefore allow us to address the wider aim of this paper, demonstrating the utility of adopting a livelihoods and ecosystem perspective when addressing issues of sustainability in systems characterised by seasonality, diverse livelihoods and rapidly evolving markets and opportunities.

Methods

Snake hunting is a widespread activity throughout the Tonle Sap basin that emerged in the mid to late 1990s (Stuart *et al.* 2000). There are two predominant forms of snake hunting. The first is what we term the 'snake fishery' where an undistinguished mix of snake species are fished from the lake using gill nets and sold mainly to crocodile farms as a food source. The second is a targeted hunt of the large individuals of the large-bodied species, predominantly the Puff-faced water snake, *Homalopsis buccata* and the Bocourt's water snake, *Enhydryis bocourti*, which are sold internationally for their skins (Brooks *et al.* 2007). Snake hunting is more prevalent in certain areas due to differences in the availability of snakes, in local markets and in alternative livelihood options.

Our first step was to identify the areas where snake hunting occurred and to locate study villages within these areas. Within study villages we carried out a range of survey methods (described in more detail below) to determine the role of snake hunting within the livelihood system. We did this through qualitative and quantitative enquiry that aimed to understand the factors that influence its uptake as a livelihood activity. These factors include wealth, available sources of income, seasonal activity profiles, assets held and required to hunt, and temporal trends and changes occurring on the lake. The economic unit of analysis in this study is the household, as our preliminary enquiries suggested that it is the consumption needs of the family that are determining livelihood strategies, rather than that of the individual. Rural households in poor countries typically adopt a range of livelihood activities which are carried out by different household members at different times in order to secure a year-round income, and therefore decisions regarding these activities are usually made at the household level. Through group discussions with snake hunters we also address the factors that threaten the snake populations and assess the potential for management intervention. All interviews and discussion groups were carried out in the Khmer language by SEB and

one or two research assistants who translated and facilitated. The research assistants were from urban areas in Siem Reap and Phnom Penh and therefore did not know any of the respondents.

Study Site

Visits to various locations throughout the Tonle Sap basin showed snake hunting to be a widespread activity in floating and stilt communities located on or at the lake's edge, but that it was far more prevalent in some villages than others. We selected study villages by identifying the origin of hunters at one of the main hunting grounds, which was being monitored as part of an ongoing program to assess snake catches. Rapid questionnaires at this location showed that 74% of hunters are from floating villages in Battambang province (Fig. 1). Due to the large number of hunters from this area, we carried out rapid surveys, in-depth interviews and focus group discussions in three villages in Kaoh Chiveang commune, Battambang. All three villages are entirely floating and have no year-round direct access to land. Two of the villages (Prek Toal and Anlong Taour) are geographically adjacent to one another and residents have almost equal access to services and resources. Kbal Taol is approximately 30 km away from the first two study villages and differs slightly with respect to the services available. It has fewer healthcare services and schools and it is less visited by development and conservation organisations; it is closer to some of the main fishing and hunting areas but further from the main market area where snakes are sold (Fig. 1). These villages lie within the inner zone of the floodplain of Tonle Sap, where there are an estimated 15–16,000 households within approximately 90 villages (Keskinen 2003). While our results cannot be extrapolated across all villages, based on observations and interviews in other floating villages around the lake, snake hunting is also prevalent in many of them.

Wealth Ranking

Households in all study villages were divided into four wealth categories; very poor, poor, medium and rich. The proportion of households within each category was based on estimates provided by the head of each village and our samples of households were representative of these proportions. Interviews with village chiefs also provided us with the criteria that they use to categorise households into the four wealth ranks. All of these villages are floating communities and the categories provided were identical in each. Of the various descriptions of wealth provided, those based on house type and large assets noticeable upon approaching the house, were chosen as the criteria in this study and are given in Table 1. Triangulation of our wealth

rankings with those of the village chief in one of the study villages showed agreement in 40 out of 44 households in that village, with the four different cases being placed in the adjacent category. We are therefore confident that our method was sufficiently accurate.

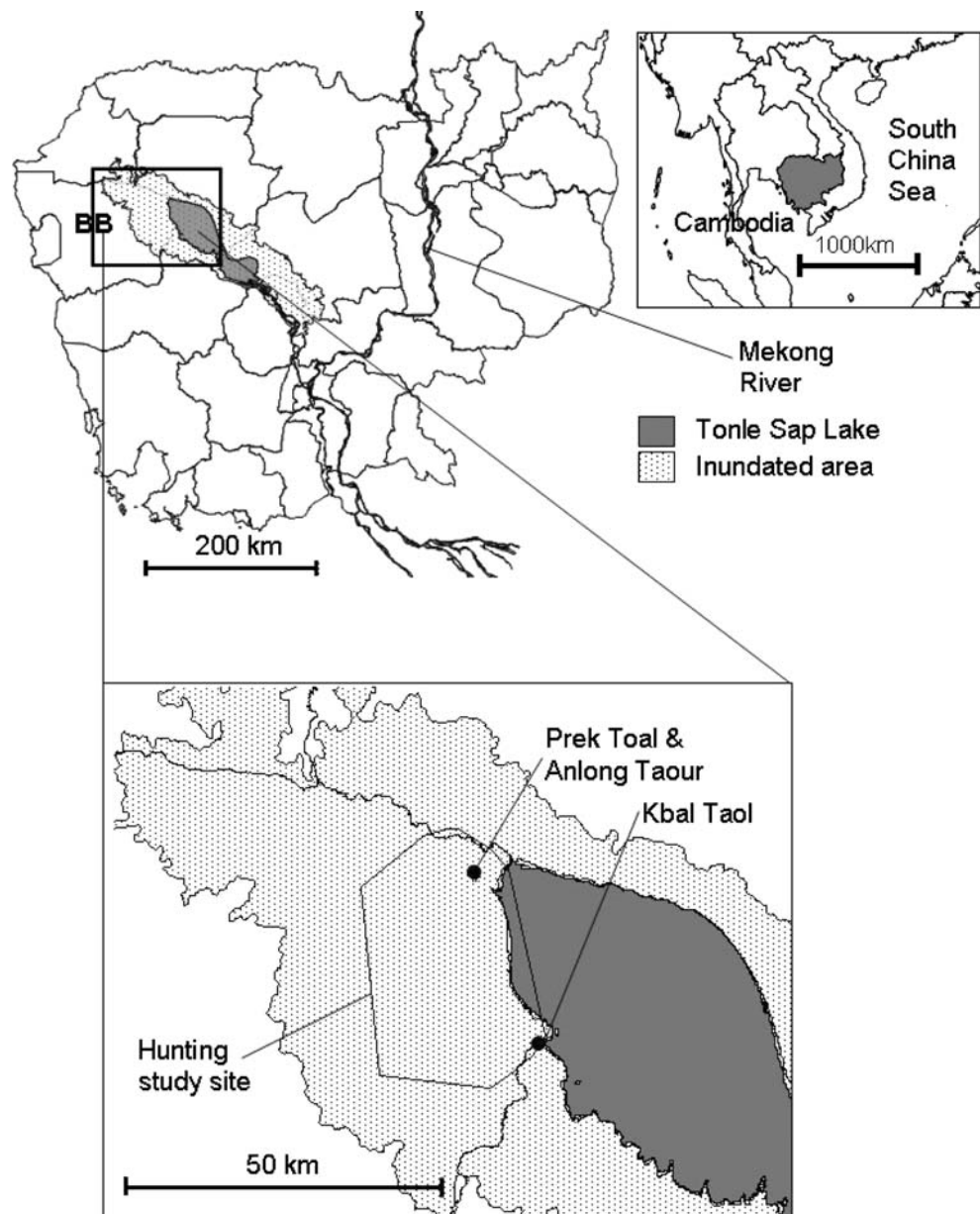
Household Surveys

We conducted questionnaire surveys in 151 households within the three villages. Houses of each wealth rank were chosen by approaching every fifth house passed of each wealth rank when paddling around the village and interviews were only conducted when adult male or female members were home. A structured interview based on a questionnaire was conducted for all households, which included both demographic profiles (household size, age, education, physical assets owned and loans taken and provided) and activity profiles (all income earning activities, the months they are carried out, the frequency per month and income earned per day). A further structured interview regarding snake hunting was conducted if that household engaged in this activity and the snake hunter him/herself was home and available for interview. This was also based on a prepared questionnaire and included information on the hunting and trade of snakes, temporal changes, why they started, their perceptions of laws governing resource use, and how they would respond to future changes in resource availability or access regulations. While people who catch snakes are termed 'hunters' throughout the paper, the term 'snake fishing' is used in particular reference to hunting snakes with gillnets.

Focus Group Discussions

In each village, people who were identified as snake hunters during the household surveys were invited to attend a group discussion. The groups consisted of 15 to 20, mostly men between the ages of 20 and 50, as very few women hunt snakes. Wives of snake hunters that were not able to attend were often present. So, too, were children but they did not participate. These discussions lasted for one day and lunch was provided as a small incentive to stay. We started with a general discussion regarding people's overall portfolio of activities, the relative importance of each activity to their livelihoods and spatial and temporal patterns of resource use. Timelines and spatial maps were used to aid this process. We then focused on snake hunting to gain an understanding of changes in this resource spatially and temporally, as well as the threats the snake populations are facing. We then moved on to discuss the future, firstly by asking what solutions they could envisage to

Fig. 1 Map of Tonle Sap Lake showing the provincial boundaries, including Battambang province (BB), the location of three study villages and the location of the hunting study site where the catch monitoring program was carried out



each of the threats they had highlighted, and then by introducing the various kinds of intervention that could hypothetically be brought in, and asking how they would respond to these changes.

Resource Dynamics

The breeding patterns of the exploited snake species were combined by averaging the proportion of females breeding

Table 1 Criteria used for wealth ranking household in floating communities

Wealth	House features
Rich	Large painted house made of good quality wood, containing furniture, often a shop or petrol station, often with large crocodile farm, many engine-powered boats
Medium	Medium sized wooden painted house with some furniture, one engine-powered boat, small crocodile farm, more than two paddleboats
Poor	Small house made of leaf bamboo or old wood, roof made of metal or newly replaced palm leaf, no engine-powered boat, one to two paddleboats, no or very few items of furniture
Very poor	Small house made of very old materials, typically leaf bamboo, sometimes wood, old bamboo under the house and the floor is often close to the water, leaky roof, no or one very old paddleboat

across all seven species, weighted according to their proportion in the catch. The data on individual species are presented in Brooks *et al.* (in press). The data on catch composition, taken from the catch monitoring program conducted in the flooded forest in Battambang province (Fig. 1), were provided by local fishers hired to work on the project and are given in Table 2.

Results

Temporal Livelihood Changes and Snake Hunting

A timeline of events and changes taken from group discussions with snake hunters in the three study villages highlights the steady decline in resources available to people (Fig. 2). In all groups, hunters referred to a first initial period of resource decline and a more severe one in later years. Resources referred to a range of animals that people use, including fish, snakes, turtles, water birds, monkeys and crocodiles. There was consistency in the timing of these changes between groups. The events and changes highlighted by focus group participants as occurring during this period provide an indication of the possible causes of the perceived decline in resources. Following the end of the Khmer Rouge regime in 1979 there were no markets and fishing was largely on a subsistence basis, with a low human population and no commercial fishing. An initial period of resource decline was reported by villagers at the three sites as occurring from 1987 to 1995. During this time participants reported that fishing gear was ‘modernised’, subleasing of the streams and ponds began by the fishing lot¹ owners, and markets for fish opened up, increasing trade. Fishing for snakes to supply food for crocodile farms was reported to have taken place during a period of increased diversification of livelihoods and at the same time as the boom in the crocodile industry and aquaculture in the mid to late 1980s. This timing of the start of the aquaculture and crocodile industry boom, as identified by participants, is consistent with reports from the government’s Fisheries Administration (So *et al.* 2005). Based on our sample of snake hunters, there has been high recruitment for supplying crocodile food in more recent years compared to that for the trade in skins, which is consistent with the data provided in the time-line (Fig. 3).

¹ Fishing lots are state owned, physically demarcated commercial fishing domains within the floodplain and lake that get publicly auctioned by the governmental Fisheries Administration every two years to fishing lot owners. Fishing lot owners subsequently sublease areas within lots (ponds and streams).

Table 2 The catch composition of snake species within the hunting sites of Battambang province

Species	Catch composition (%) $n=42,807$
<i>Enhydryis enhydryis</i>	72.4
<i>Enhydryis longicauda</i>	11.5
<i>Homalopsis buccata</i>	5.6
<i>Erpeton tentaculatus</i>	5.1
<i>Xenochrophis piscator</i>	2.8
<i>Cylindrophis ruffus</i>	1.3
<i>Enhydryis bocourti</i>	1.2

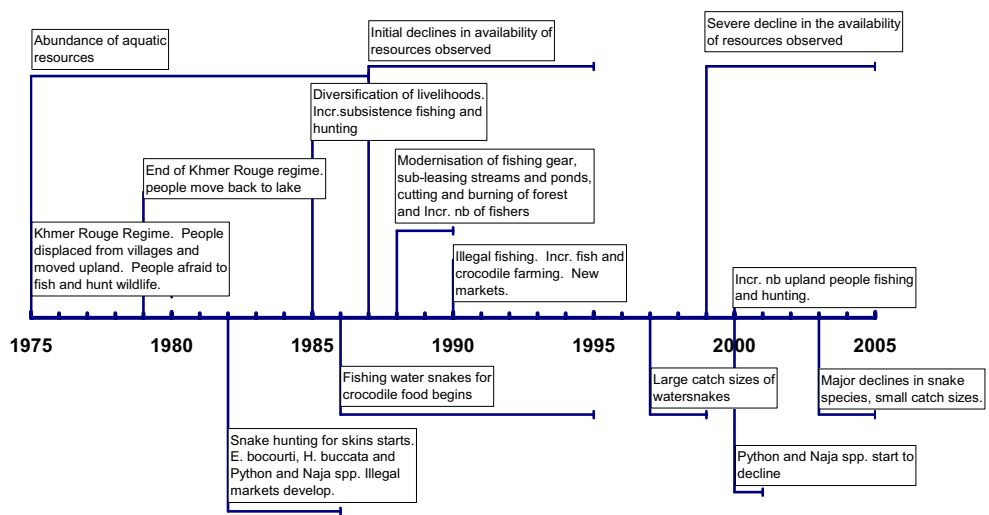
The sample size is based on recorded catches from the catch monitoring program

Seasonal Activity Profiles

In 2005, a total of 35 separate activity types were identified through the household surveys in the three floating villages. These were grouped into five main categories; fishing, hunting and gathering, trade and processing, livestock rearing (aquaculture, crocodiles, pigs, ducks), employment (wage labour and self-employment) and remittances (money earned by family members working in other areas remitted back to the household). While a few households may grow vegetables in floating gardens for home consumption, there is no seasonal crop farming in these villages due to the lack of access to land. Only two households referred to remittances. This may reflect a high degree of social and economic isolation of the floating villages of Tonle Sap from the wider labour market, or it may be an underestimate, as people may not have regarded this as an income earning activity and therefore not mentioned it (Table 3).

The degree of seasonality varies greatly between activities, with activities such as livestock rearing and the trade of food showing little variation in the number of people engaged throughout the year. The direct resource-use activities, hunting and gathering and to some extent fishing, show a strong relationship with the fluctuating level of the lake, occurring when the water level rises. The major form of employment, wage labour in fishing lots, shows the opposite relationship occurring during low water levels (Fig. 4). Fishing lots operate between October and May, with the major fishing season occurring as the water recedes from the forest. During this time, while opportunities for employment within the lots exist, local people are excluded from using the areas of the lake covered by lots, and options for family fishing are reduced. The seasonality of livelihood activities is therefore heavily influenced by the rights of access of local people. While there are areas to which the local communities have year-round access, mapping exercises with members of discussion groups showed that there are very few resources available within

Fig. 2 Time line of events and changes perceived by members of the focus group discussion meetings. Generic events and changes are above the time line and events and changes regarding the snakes are shown underneath. Variation between groups in the timing of events and changes represented by the duration *bar* beneath the text



these areas. People first indicated where they go to find a variety of resources including wood, fish, snakes, turtles, crocodiles, birds and monkeys. Afterwards we asked them to draw the boundaries to the fishing lots. Almost all of the resources they had drawn on the map were inside the

fishing lots. Many of the lake’s resources are therefore exploited by local people as the Tonle Sap floodplain becomes inundated and the whole area is open access.

The data presented in Fig. 4 are based on the number of people within our representative household surveys who engage in each activity in each month. They therefore do not represent the seasonal change in incomes that also occurs throughout the year. For example, gill net fishing occurs through most or all of the year, yet catches will vary considerably as a result of the seasonal change in the availability of different fish species throughout the year.

Prior to the sudden peak in the availability of many resources with the arrival of the flood waters, the people of Tonle Sap undergo a lean period. Even those who have secured incomes from less seasonally dependent activities, such as trade and services, are likely to be affected as a result of a drop in the availability of tradable commodities and income-earning customers. Of the high water income-earning activities following this lean period, snake-fishing is the first to be taken up. This typically begins in June, whereas many other lake-based activities are not available until August (Fig. 4).

Importance Ranking

During focus group discussions with poor and very poor households, people ranked activities in order of importance. The basis of whether an activity was considered important was the reliability of deriving income from it throughout the year, rather than on the income earned per day. Opportunistic activities were not viewed as important, despite the potential for high income, as they could not be relied upon. The gill net fishery, which primarily targets fish, was viewed as the most important activity in all three discussion groups and was termed as analogous to ‘a rice store’ for agricultural communities, as it allowed them to purchase rice year round. This analogy was also frequently

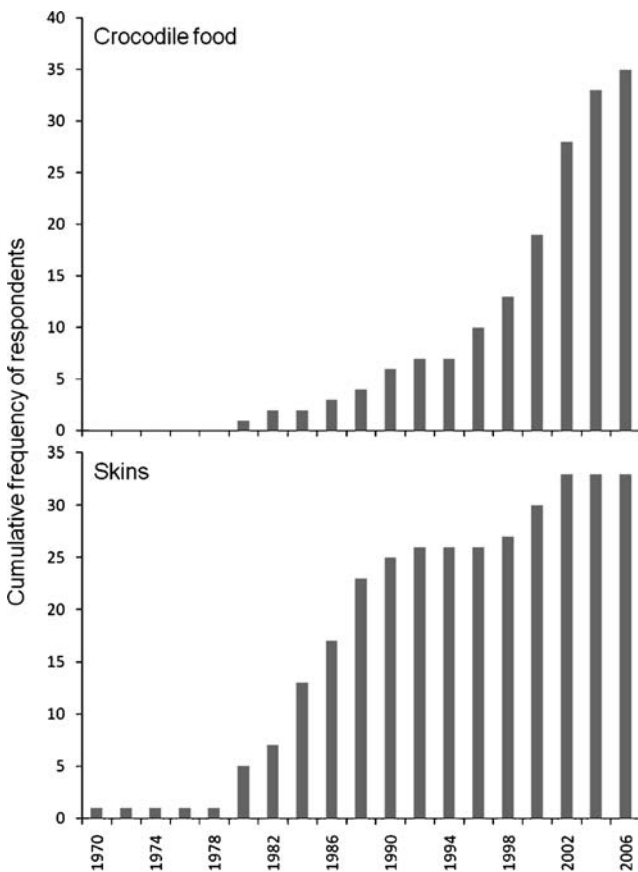


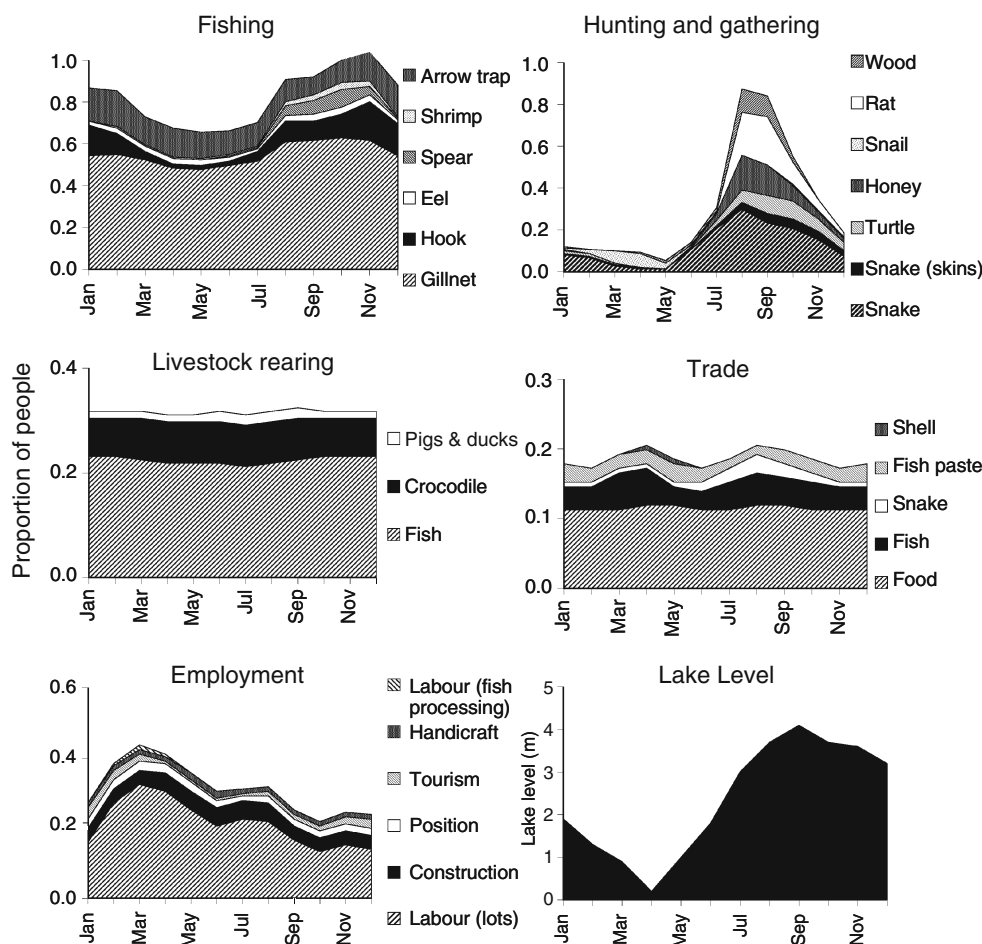
Fig. 3 Recruitment into snake hunting shown by the cumulative frequency of new snake hunters in each year based on interviews whereby snake hunters were asked in which year they started hunting. The *top graph* is for the gill net snake fishery and the *bottom graph* represents hunting the large snakes for their skins

Table 3 Mean annual gross income per household derived from identified income sources

Activity	Mean Annual Income (US\$) ± SE				Mean % Total Annual Income ± SE				% sample engaging in activity			
	VP	P	M	R	VP	P	M	R	VP	P	M	R
Fishing												
Gill net	552±13	618±82	669±110	0	47±4	45±4	32±6	0	75	80	72	0
Hook	246±13	348±99	626±167	0	21±4	20±5	27±8	0	29	34	31	0
Trap	419±68	769±171	1,464±299	13,917±7,496	31±11	36±6	43±7	76±24	12	25	38	17
Spear	63±8	128±37	30±20	0	10±7	12±2	1±1	0	14	13	6	0
Line	62±14	0	0	0	20±4	0	0	0	6	0	0	0
Shrimp	0	419±111	0	0	0	41±16	0	0	0	8	0	0
Eel	431±139	373±259	0	0	21±3	26±13	0	0	6	7	0	0
Hunting and gathering												
Snake	289±13	261±33	376±103	0	20±4	20±3	13±4	0	39	44	47	0
Snake (skins)	232±77	497±439	188	0	15±4	4±1	3	0	6	8	3	0
Turtle	581	234±78	205±78	0	34	17±5	7±3	0	12	13	16	0
Rat	62±4	51±11	49±17	0	12±5	6±2	7±5	0	29	28	22	0
Snail	96±17	238±122	0	0	9±3	20±11	0	0	12	12	16	0
Crocodile	0	1,341	201	0	0	62	3	0	0	2	3	0
Honey	91±7	148±43	40	0	11±3	11±3	1	0	21	26	6	0
Wood	83±27	117±48	225	0	8±7	6±2	6	0	19	16	16	0
Employment												
Labour in lots	199±5	173±37	282±54	0	23±4	16±3	14±3	0	81	59	38	0
Fish processing	0	52.5	101	0	0	9	3	0	0	2	3	0
Boat building & repairs	101±45	95±36	14	0	37±29	4±1	1	0	6	10	3	0
Wildlife ranger	770	770	0	0	75	50	0	0	2	2	0	0
Appointed positions	225	100±35	142	0	34	21±19	2	0	2	3	3	0
Boat driving	0	40	0	165	0	4	0	33	0	2	0	17
TV repairs	0	0	9,000	0	0	0	100	0	0	0	3	0
Music/karaoke	0	109±71	0	0	0	0	0	00	0	3	0	0
Wine making	0	0	1,845	0	0	0	94	0	0	0	3	0
Tourist guide	52±12	58±33	0	0	3±1	11±8	0	0	6	7	0	0
Handicraft	171±91.5	126	0	0	12±10	30	0	0	4	2	0	0
Trade and processing												
Food	238±18	922±326	1,280±700	330	67±16	82±12	53±14	67	15	10	25	17
Fish	0	809±479	55,520±55,265	179,375±57,875	0	27±7	38±31	91±4	0	10	9	33
Snake	0	0	469±356	7,200	0	0	3±2	6	0	0	6	17
Shells	0	30	0	0	0	1	0	0	0	2	0	0
Fish paste	58±9	0	2,166	0	6.7±1.5	0	31	9	6	2	9	17
Fish	500	625	840±329	0	29	43	33±14	0	19	28	47	50
Pigs/ducks	175	150	125	0	17	0	6	0	6	2	3	0
Crocodile	0	240	3,600	0	0	5	100	0	0	7	25	67
Remittance	25	0	0	0	8	0	0	0	4	0	0	0
All activities	1,010±97	1,444±135	3,427±7,292	74,252±44,100					(51)	(61)	(31)	(6)

This is based on income per day multiplied by the estimated number of days per month and months per year each household engages in each activity, across which an average is taken. Where ranges were given the midpoint was used. The proportion of the population engaging in each activity and the average proportion of their total income derived for each activity are also given. All data are shown separately for each wealth group; very poor (VP), poor (P), medium (M) and rich (R). Mean total gross income and sample size is provided on the last row

Fig. 4 Seasonal livelihood activities grouped into five activity types. The y-axis represents the proportion of people within our study villages carrying out each activity in any given month. The corresponding level of the lake is given in the *bottom right-hand corner*



used by interviewees. ‘This is my rice field, if you compare with the people who live on the land’ (interview no. PT73), and was also extended to catching snakes with gill nets. ‘I don’t know what can I do better than catching snakes, it is the same as upland people making a rice farm’ (interview no. KT113). Our index of importance, based on the average annual income multiplied by the proportion of households of each wealth rank carrying out each activity, accords well with that of the members of the focus group discussion, particularly for the high importance activities (Fig. 5). Unsurprisingly, as people become wealthier, direct dependence on natural resource exploitation, such as hunting and fishing, as well as wage labour, declines in favour of activities such as crocodile farming, trade and self-employed activities (Fig. 5). This is due to the high levels of capital investment required to adopt these livelihood activities, which tend to generate steadier income streams and higher rates of return.

Snake Fishing as a Livelihoods Option

Although snake fishing is carried out by 38%, 44% and 47% of the people in the very poor, poor and medium wealth ranks respectively, it comprises a higher proportion

of the total annual income within the very poor and poor wealth ranks (Table 3). It ranks as the third most important activity in the very poor wealth group compared to a ranking of fifth and tenth in poor and medium wealth groups (Fig. 3), as a result of the higher income derived from snake fishing compared to other activities available in the poorer households.

This difference in dependence on snake fishing between the wealth ranks is reflected in the point at which a hunter will switch to another activity when catch size declines. Based on our observations of hunters in the field, as snake catches declined seasonally, snake fishers needed to move further from the village to continue to catch snakes. Those of higher wealth, according to the hunters in the area, who owned hook-and-line fishing gear, switched to exploit the large snakehead fish (*Channa striata*). Those with no such fishing gear continued to move with the shallow edge of the lake water to catch snakes, despite the low catches and the increasing distance from home.

Snake Fishing and Assets

Adopting new livelihood activities such as snake fishing may be limited by the number of people within a

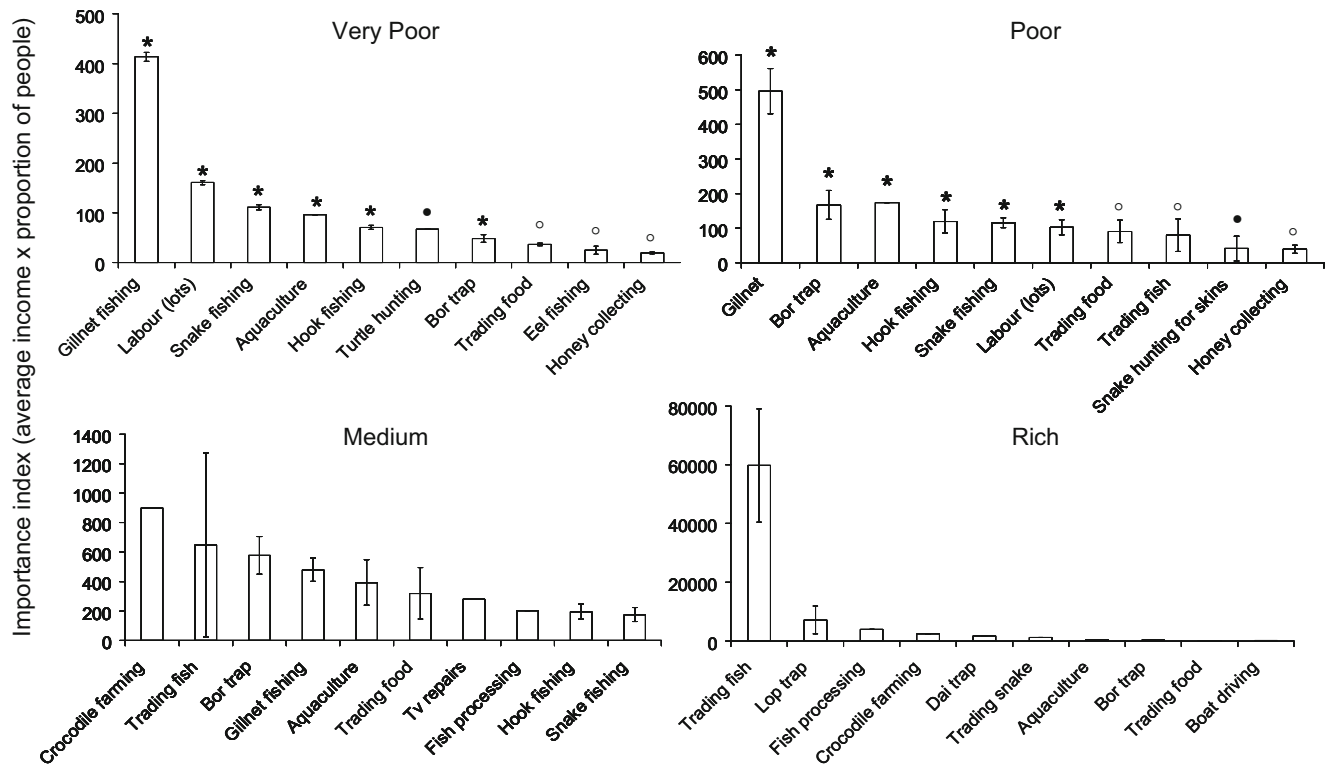


Fig. 5 Importance indices for the top ten activities within each wealth rank, measured as the average income earned from each activity multiplied by the proportion of the community of each wealth rank engaged in that activity. Standard error bars represent the variation in income earned. In the poor and very poor wealth ranks the importance

rank attributed by respondents to each activity during focus group discussions is denoted by the symbols above the bars. (asterisks = very important empty circles = important filled circles = low importance)

household, a crude indicator of human capital, as well as the type and quantity of particular assets owned, such as boats and gill nets. Snake-fishing households were significantly larger than non-snake-fishing households (two-tailed t -test: $t=2.3$ $df=149$ $P<0.05$) with a mean household size of 6.3 ± 0.3 and 5.3 ± 0.3 respectively. There was no significant difference in household size between different wealth ranks (ANOVA: $F_{3, 147}=1.2$, $P=0.3$). Snake-fishing households had significantly longer gill nets than non-snake-fishing households (one-tailed t -test: $t=2.3$ $df=149$ $P<0.05$). Respondents who owned gill nets to catch fish at certain times of the year, but did not target snakes, claimed they did not own enough gill net to catch snakes and some households that previously fished snakes have stopped due to limitations in the amount of gill net owned and the decline in the resource. Snake-fishing households also owned significantly more boats than non-snake-fishing households, based on a two-factor ANOVA that included wealth as a factor ($F_{1, 145}=5.7$ $P<0.05$).

Based on the number of income-earning activities adopted by a household, those that engage in snake fishing are more diversified, both overall and within each wealth rank (Table 4). Within the very poor wealth rank, snake fishers have a significantly higher income than nonsnake

fishers (two-tailed t -test: $t=-3.25$ $df=49$ $P<0.05$) and, although insignificant, this difference still exists even if the income derived from snake fishing is removed from the household’s total income ($t=-1.87$ $df=50$ $P=0.07$). Income was also higher in snake-fishing than non-snake-fishing households in the poor and medium wealth ranks, but was not significant in either (poor: $t=-0.047$ $df=55.5$ $P=0.64$, medium: $t=-1.36$ $df=28$ $P=0.19$). It is not possible to know whether higher income is a necessity to enter snake fishing or whether it results from it. However, it is apparent that, at least in the lowest wealth rank, snake fishing is an occupation of the relatively better off.

Decision Making Over Snake Fishing

When people were asked how they decide whether to catch snakes or not, their responses followed major themes. Out of 54 hunters interviewed, 57% said that it was a seasonal activity and the season dictates what they catch, 46% said it was in response to declining fish catches, 28% and 4% due to the high snake and low fish prices respectively, and 22% due to requests for snakes from traders. Snake fishing is thereby a response to seasonal fluctuations in resource availability and market demand and prices.

Table 4 Mean number of activities per household in three wealth ranks, in snake-fishing and non-snake-fishing households

	Very poor	Poor	Medium	Total
All	4.3	4.6	4.5	3.3
Snake-fisher	5.4	5.4	6.6	5.7
Non snake-fisher	3.6	4	2.7	3.6
<i>t</i> (<i>df</i>)	3.6 (48.6)	2.8 (59)	4.7 (30)	6.2 (149)
<i>P</i>	<0.001	<0.01	<0.0001	<0.0001

Debts, Hunting and Vulnerability

Overall, 59% of the households surveyed were found to be in debt—a source of vulnerability and a potential driver of more intense exploitation of natural resources. The purpose of these loans varies considerably between wealth ranks. As wealth increases we see a reduction in the proportion of loans used for basic daily needs such as food and health care, and an increase in the proportion used for developing assets for livelihood activities such as farming, aquaculture and trade (Table 5). A contingency table analysis revealed that snake fishers were 1.55 times more likely to be in debt than non-snake fishers ($\chi^2(1)=5.5$ $P<0.05$). Of these debts, 73% were for purchasing fishing gear necessary to catch the snakes, compared to an overall 61% of debts used for fishing gear.

The mean total interest paid on loans is $12.0\pm 1.7\%$ per month and ranges between 0.25% and 30.0% per month, with one respondent reporting a 50% interest rate per month. Although there is no statistically significant difference in the mean interest rates paid between wealth ranks, the upper range is dominated by the poor wealth ranks (Table 5). Although fewer of the very poor pay interest compared to the poor wealth group, they more often have a

trade agreement with the money lender which often contains a hidden interest rate in the form of having to sell to the trader at lower prices. Of the snake fishers we encountered during the household survey, 67% had an agreement with a trader. Within this region traders typically loan money to fishers to buy fishing gear in order to secure a supply. In these situations the fishers must sell their catch to their money lender, often at a noncompetitive price. Loans from relatives incur no interest and the proportion of people taking these loans is far higher in the medium wealth rank compared to the poor and very poor. The poorer snake fishers are therefore subject to a greater risk of taking out loans and/or are tied to traders and unable to benefit from new opportunities that may arise.

Resource Dynamics and Hunter Activity

We overlaid the seasonal change in snake fishing, based on data from the household surveys, with the seasonal biology of the exploited snake species. This showed that the peak hunting period, when snakes are of high importance to people's livelihoods, coincides with one of the two breeding periods of the snakes (Fig. 6). The breeding period is shown as a mean of seven species, weighted according to their abundance in the catch (Table 2), and it is therefore dominated by the most abundant species, *Enhydryis enhydryis*. This species differs from the others in this snake assemblage as it breeds twice a year, and this is reflected in the large error bars from July to September when only one other species is breeding. The other season, between November and March, coincides with the breeding season of the majority of other species. From a conservation perspective this breeding period is therefore of greater importance (Brooks *et al.*, *in press*).

Table 5 The purposes of taking loans based on percent respondents in each wealth rank as well as the interest and/or agreement tied to each loan

	Very poor (<i>n</i> =28)	Poor (<i>n</i> =39)	Medium (<i>n</i> =23)	All
Purpose of loan (% respondents)				
Fishing gear	60.7	59.0	65.2	61.1
Food	28.6	20.5	17.4	22.2
Livestock and aquaculture	17.9	28.2	39.1	27.8
House building and repairs	3.6	7.7	8.7	6.7
Boat/boat repairs	7.1	2.6	4.4	4.4
Health	21.4	2.6	4.4	8.9
Tradable commodities		2.6	8.7	3.3
Funeral expenses		2.6		1.1
Interest and agreements				
% Paying interest	46.4	65.8	45.8	54.4
Mean interest paid \pm SE	12.7 \pm 3.5	12.0 \pm 2.6	11.3 \pm 2.9	12.0 \pm 1.7
% Trade agreements	50.0	26.3	25.0	34.4
% Loan from relative or neighbour	7.1	5.3	16.7	8.8

The sample sizes represent the number of households in each wealth rank that have taken out loans

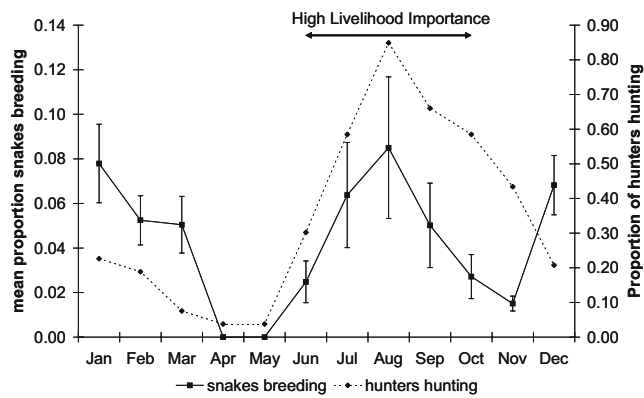


Fig. 6 The proportion of snakes breeding, taken as a mean across seven species weighted according to their relative proportions in the catch, and the proportion of hunters hunting in any given month. The time of year when snake hunting is an important livelihood activity according to members of the focus group discussions in the study villages is indicated by the arrow above the graph

Threats to Snake Populations and Possible Management Responses

Based on the perceptions of hunters, snake catch sizes have declined in this area by approximately 80% over the last 5 to 8 years (Brooks *et al.* 2007). We grouped the threats hunters perceived as contributing to the observed decline in snake catches into five categories (Table 6). These include direct threats, such as hunting and habitat loss, as well as indirect threats, such as the markets that are driving the exploitation. Some of the threats were not mentioned by all groups, and in these cases missing values were replaced with mean values. Habitat alteration showed the highest mean rank across the three groups, followed by illegal and destructive fishing. Direct exploitation threats were ranked as the third highest threat category overall. During the discussion in Kbal Taol village the group identified forest burning for land clearance as a greater threat to the snakes than hunting because, as one person put it “the burning of the forest kills all snakes, even the small babies or eggs, but we do not hunt the babies, only the adults”.

The solutions that discussion-group members offered to mitigate the threats they highlighted were almost identical among groups, with complete consensus within groups. They requested protection of the forests to prevent the burning, and enforcement of laws to prevent illegal activities such as stream and pool pumping. This activity occurs during the dry season after the flood water has receded from the forest and involves pumping the water from the remaining water holes and streams in order to extract fish that become concentrated in these areas. These pools contain much of the spawning stock of many fish species, and according to local people they also contain many snakes. This activity is illegal under the fisheries law, but is carried out by the elite, in collusion with rent-seeking

officials. Regarding the threat of overexploitation, all three groups asked for support to provide credit to facilitate access to alternative livelihoods. In all cases they wanted to set up livestock farming of pigs or ducks in floating cages and pens next to their house.

The existing law governing the hunting and trade of snakes is unclear. While the Ministry of Environment has wildlife protection laws that prohibits hunting, water snakes, along with other aquatic forms of wildlife such as crocodiles and turtles, have recently been moved under the jurisdiction of the Fisheries Administration within the Ministry of Agriculture, Forestry and Fisheries (MAFF). However this department has made no specific laws to govern the use of water snakes and permits can be legally sought to export these snakes, alive or as dried skins, from the country. Moreover, people’s perceptions of the law are highly variable. Out of 51 hunters, 61% believed water snake hunting was illegal, with 6% believing it was legal and 33% unsure. Out of 20 traders, 15% believed it was illegal, 65% legal and 20% unsure. Despite the fact that the majority of hunters believed this activity to be illegal, none had encountered any enforcement that prevented them from hunting snakes.

The research team put forward four conservation measures that could hypothetically be implemented in order to protect the snakes. These are total bans, protected areas, closed seasons, and fishing gear restrictions. Responses to intervention were consistently dramatic and are given in Table 7. People opposed any idea that would limit their catches due to the fact that they currently struggle to meet their family’s income needs. Reducing their hunting activities would only be considered if support was simultaneously made available to acquire the assets to pursue alternative livelihoods. However, in all three groups they agreed with the idea of a closed season to protect the snakes during the main breeding season, from November to June. In these villages snake fishing is not considered an important livelihood option during these months. Participants informed us that during these months, people from agricultural communities on the land move to the flooded forest to fish and hunt snakes and other wildlife. During the discussion held in Kbal Taol village, where people had voiced their understanding of ecological issues, we discussed options for reducing the capture of immature and large fecund female snakes that is likely to have greater impact on their populations (Brooks *et al.* 2007). Several members of the group agreed with the concept and responded by saying that they were unable to reduce the capture of immature snakes, as the use of the small mesh sized gill net was essential to catch enough snakes, but that the capture of the very large snakes was less important to them.

The responses of hunters to restrictions on hunting were also quantified through questionnaires. When asked ‘what will you do if this activity became illegal’ one respondent

Table 6 Threats to the snake populations, ranked from focus group discussions in three villages, Prek Toal (PT), Anlong Taour (ALT) and Kbal Taol (KT)

Threat category	Threat	PT	ALT	KT	Mean rank
Habitat	Stream and pond pumping	3	3	2	2.67
	Forest burning (natural)	3	3	3	
	Intended forest fires	3	3	3	
	Forest logging			3	
Exploitation	Increased human population/hunters	2.3		3	1.82
	Increase in effort (fishing gear) to catch snakes	1			
	Decrease in mesh size used			3	
	Increase in hunters from upland		2		
Illegal fishing activities	Illegal fishing gears, including small size mesh			2	1.91
	Electro fishing	1.7	3		
	Poison to catch birds		3		
Markets	International export of snakes		2		1.80
	High price of snakes on market		2		
	Use of snakes as crocodile food		2	2	
	Increase in human consumption of snakes, including sale of snakes to restaurants		1.5	1	
	Increased number of snake traders	2.3	2	3	
	Use of snake blood in traditional medicine		1	3	
Policy and law	Weak fishery law and corruption			1	1.67
	Privatisation of main streams	3			
Biological traits	Low fecundity of snakes			1	1.33

Scores are between 1 and 3, where a high score reflects a higher ranking threat. Missing values were replaced with a median score of 1.5 and a mean rank was obtained from the average of all threats in all groups within each threat category

answered ‘then I will stop and sleep until I die, because this is my job on the lake. If they don’t let me catch the snakes in the snake season, what do you think I can do? People on the upland can farm rice but here we can not’ (interview no. KT138). While 56% said they would catch fish if they could not hunt snakes, 78% followed with a further statement about the detrimental impact on their livelihood, 27% respondents referred to ‘death’ in their family that would result from such restrictions and 23% said they would continue illegally. Dramatic responses were common. ‘If this activity is banned, I would like to ask back ‘do they want people to die or the snakes to die?’ (interview no. PT18).

While hunters were aware of the impacts of over-hunting, they did not regard it as the main threat facing the snake populations. Furthermore, they did not perceive any way of reducing hunting without financial support to develop alternative livelihoods. We recognise that people used this opportunity to voice their requests and that these responses tell us little about how people would respond in reality. Nonetheless the other threats that hunters highlight such as stream and pond pumping need to be equally addressed. We visited several of these water holes in March 2006, all of which were being pumped. Three of the camps that we visited were inhabited by members of the same family who live in the uplands in Battambang province. Although we cannot quantify the impact of this activity, the impact per household will undoubtedly be far greater than that of hunting. The direct impact on snakes may be less

than that on fish, as the snakes burrow into the mud and are harder to find. However, as people hunt snakes in response to declines in fish catches, these illegal activities which impact the fish populations will have an indirect impact on the snake populations.

Discussion

The results of the livelihoods analysis presented above highlight the importance of situating exploited-species conservation research within a human ecology framework. The floating villages are an integral part of the highly dynamic social–ecological system that is Tonle Sap and this study of livelihood dynamics and their drivers enables us to understand the likely role of externally-driven change, whether it is pressures on resources generated from upland populations or new fisheries and wildlife management and conservation initiatives. The snake catches of Tonle Sap have received considerable recent attention in conservation biology circles.² Placing snake harvesting in this wider context will help inform any future conservation action.

² *New Scientist* 7th July 2007. “Snakes Alive? Not in Cambodia.” *Geographical* January 2007 vol. 79 (1). “Tipping the Scales.” *Associated Press* August 19th 2006 “Snake Harvest Threatens Cambodian Lake.”

Table 7 Responses from participants of the focus group discussion in the three villages to proposed interventions that may be considered for the protection of the snake populations

	Prek Toal	Along Taour	Kbal Taol
Total ban	We cannot accept because it will be a serious problem for our livelihood, our children will not be able to go to school, we will not have enough food and clothes and will not be able to get medicine and health care; if an NGO or another institution provides us with alternatives we can stop, but if not supplied we will continue snake hunting even if illegal	We will be poorer, children will not be able to go to school, will have no money for health care and we will die as we will have no money for food; we have no other options, may be we will become thieves, we will have to continue hunting illegally; we will catch fish but if no fish and it is the snake season we will catch snakes	We have no choice, we would have to follow the law, but we would request support to change our livelihoods from snake hunting to aquaculture, chicken, ducks and pig farming; <i>If they do not support you?</i> ; we will try to find [wage] labour; it will seriously affect our livelihood as during that season we will have no money for rice or food, clothes, health or for our children to go to school
Protected area	If organised outside of the areas that we use to hunt then we can accept, otherwise we cannot accept; if NGOs want to protect the snakes they should prohibit the stream pumping and forest burning and the use of electro fishing gear; the fishery law is already established and we do not accept that it should change	Some people say ‘it would be ok if they protected 10% of the area that we use to hunt snakes; some say ‘not even that much, if they want to protect areas from hunting it should be outside of the areas we currently go	We cannot accept because we do not have enough as it is; the snakes decline step by step and there are now fewer areas where we can find snakes than before; the number of snake hunters is also increasing; if the government protects areas we will still go fishing and hunting in order to provide for our families
Fishing gear restriction	We cannot accept using only the large mesh size or a reduction in length as we will not be able to catch enough to support our livelihood; we need all, especially as the amount we can catch is declining	We need both sizes [of gill net mesh size] to earn enough income; we need to use more and more [fishing] gear every year to catch enough snakes as the resource is declining	<i>Min mesh size</i> —this would be a problem for us as we catch many snakes in 2.5 cm mesh size; <i>max mesh size</i> —this would not be a problem for us as the large snakes are not so important to us
Closed season	We agree because we don’t catch snakes all year	We only hunt snakes from July–October, after this time it is the people from upland that go to catch snakes; if the season was closed from October to July we would not have a problem as long as they can hunt in these 3 months	We can accept a closed season as long as we can hunt from June to July; it can be prohibited for the rest of the year and will not affect us, we would agree with that; the people that hunt snakes from August to March are from other areas

Snake fishing is a significant livelihood activity within floating communities on Tonle Sap Lake, which is of increasing importance to the less well-off as a result of reduced livelihood options. It provides a source of income at a critical time of year when few viable alternatives are available, thus forming an integral part of people’s seasonal livelihood strategies. As this is a new form of exploitation that is partially driven by declining fish catches and is seemingly unsustainable, it may be viewed as one that is poverty-driven and destructive. However, it is also linked to higher incomes, new market opportunities and potentially reduced vulnerability to livelihood stresses. Nonetheless snake catches are in decline and the challenge is to find ways of managing natural resources for future generations without compromising the needs of people in the present. Here we discuss how the uptake of snake fishing is an adaptive strategy adopted by Tonle Sap fishers to deal with

the prevailing uncertainty of their livelihoods. We discuss the potential for intervention, potential pitfalls of rigid strategies and how adopting a wider pro-poor perspective may move us further towards the goal of sustainable and equitable resource use.

Drivers of Change

In the late 1980s, following more than 30 years of civil conflict, Cambodia embarked on a transition from an agrarian subsistence to a market orientated economy, initiating economic growth and political stability within the country. Nonetheless it remains one of the poorest countries in the world (UNDP 2005). This study, among others, has shown that resource decline, along with the high and potentially increasing levels of poverty, are the major concerns for the Tonle Sap region (Keskinen 2003; Lamberts 2001). Many

refer to ‘poverty-driven destructive practices’ as the major threats to the natural resources (ADB 2005; Varis and Keskinen 2003), supporting the view of a deterministic and detrimental linkage between poverty and the environment of Tonle Sap. However the real drivers of change are the emerging markets and destructive activities have been shown to not be limited to the poor (De Lopez 2002).

Targeted snake fishing appears to have arisen as a result of the growth of the crocodile farm industry. Although such markets may lead to overexploitation of resources they also provide livelihood opportunities through possibilities for diversification and livelihood reorientation (Rigg 2006). This is shown here through the sale of snakes. Market integration thereby provides a potential escape route from this ‘spiral of decline’ by raising incomes and reducing vulnerability to resource declines. However, under weak resource governance where property rights are uncertain and largely open access, these new market opportunities can exacerbate resource decline, compromising future benefits of market integration (Kurien 2005).

Livelihood Diversification

Snake fishing is a form of livelihood diversification adopted by all but the rich fishers on Tonle Sap. Diversification is a universal adaptive response for risk mitigation across rural economies where uncertainty prevails (Ellis 2000; Marschke and Berkes 2006; Turner *et al.* 2003). Despite the view of fishers as specialists, diversification is a prevalent feature of fishing livelihoods due to the seasonal and uncertain nature of fisheries resources (van Oostenbrugge *et al.* 2004).

However, the reasons for diversification vary between wealth groups based on the two overarching considerations of necessity and choice (Ellis 2000). For the wealthier, a large household size and more financial capital to invest in boats and fishing gear allow a household to diversify in activities such as snake fishing as a means to increase their income. In the poorer households it is more often a necessary response to survive the uncertain and unstable nature of natural resource-dependent livelihoods. However, rather than being a ‘last resort’ activity that leads a household into a more vulnerable position, snake fishing represents a new opportunity that requires certain assets and is linked to higher incomes and reduction of vulnerability to resource fluctuations and declines.

Intervention for Sustainable Use of Natural Resources

Intervention that fails to consider the complexities of livelihood strategies is likely to fail or produce counterproductive outcomes. For example, rigid policies implemented as part of sustainable development programs, such as those

involving the sedentarisation of pastoralists on semiarid African rangelands and in inner Mongolia, and those that work to increase the efficiency of fishing effort in low income countries, have failed to account for the adaptive flexibility of resource use, leading to increased ecological degradation and conflict among resource users (Allison and Ellis 2001; Fernandez-Gimenez 2002; Kamara *et al.* 2004). The flexibility to target species according to availability can be adaptive in the sense that it can prevent the unsustainable exploitation of any single resource. This could be regarded as an optimal foraging strategy from which, some suggest, resource conservation may be a consequence (Alvard 1993; Aswani 1998). However, this is only likely to be the case in situations where an increase in rarity does not lead to an increase in value, as has been highlighted as a major threat to rare and exploited species (Courchamp *et al.* 2006). While it has been realised that different resource-use activities are linked, further research is needed to understand optimum strategies for resource conservation that encompasses the range of resources available for use (Rowcliffe *et al.* 2005).

As few assets are required to enter the snake fishery, which is an open access resource for much of the year, it has become an option available to many to supplement incomes during lean periods. However, the debt incurred by some hunters in order to target snakes prevents movement out of this activity when new or more profitable activities are available. Improving the availability of microfinance services (small-scale loans, savings and insurance schemes) may be a way to increase flexibility of Tonle Sap fisher livelihoods (FAO 2006).

Coping strategies that are pursued because of a lack of alternatives tend to be very costly, either to the environment or future development options or both (Start and Johnson 2004). We have shown how a large proportion of the very poor in this study enter negative debt cycles by taking loans to cover the costs of basic daily needs such as food and health, an example of a desperation coping strategy. This study has demonstrated the lack of viable alternatives available to Tonle Sap fishers in our study sites at the beginning of the snake hunting season. There is therefore a high likelihood that many would resort to desperation strategies and/or suboptimal foraging strategies if access to this resource was restricted at this time of the year. Such activities may include fishing when fish density is low, illegal and destructive fishing activities, and forest clearance, which will all result in greater conflict within fishing communities. We therefore suggest that blanket bans on snake hunting and trade could be counterproductive through potentially forcing people into these less desirable activities, and more emphasis should be placed on increasing, rather than restricting access to resources. Other studies have highlighted the range of unforeseen conse-

quences of trade bans and restricted access to resources that people depend on, which include stimulating illegal activity, reduced material welfare of affected communities and increased level of conflict within communities, thus compromising the capacity to instigate long-term conservation solutions that require their support (Brooks *et al.* 2006; Cooney and Jepson 2006; Marschke and Berkes 2006; Moreau and Coomes 2006).

Although outright bans may be ineffective and/or unethical, seasonal restrictions remain possible. We have demonstrated the seasonal importance of snake hunting to the livelihoods of the poor. Due to the ecological traits of the species exploited, seasonality is also an important component in the effectiveness of no-hunting seasons for maintaining viable wildlife populations. In particular, hunting snakes before or during their reproductive period will have a greater impact on the snake populations compared to hunting after breeding seasons (Brooks *et al.* 2007). As the peak hunting period coincides with one of the two snake breeding seasons, there will be differing impacts on livelihoods of restricting hunting during each of the breeding periods. Based on the results from our study sites, a no-hunting season between November and May would help protect the snake populations with minimal direct impact on livelihoods, as although hunting continues during this time, it is of less importance due to the alternatives that are available at this time of year. Furthermore a no-hunting season during this time would have a high conservation benefit in terms of species diversity as the majority of species breed during this time. It is however likely that people migrate from other areas to hunt during this time, as reported by local fishers in this study, and therefore further research would be needed to assess the impact of a no-hunting season on other communities. Any measures to reduce hunting, whether through the provision of alternative livelihoods or through legislation, need to consider this seasonal significance in order to complement existing livelihood strategies.

Ecosystem Approach

When addressing the threats that may be responsible for resource declines, there is often a desire to focus on those that directly impact a resource. However there are often a range of threats that indirectly affect an exploited fish or wildlife population, not only through ecological means, such as a loss of habitat or prey species, but also through redirecting the target of resource users. In this system activities that threaten fish stocks will redirect exploitative pressure, impacting the snakes. Work in Gabon highlighted a similar need to coordinate the management of wildlife and fisheries in the context of human use, otherwise conservation of one may contribute to depletion of the other (Wilkie

et al. 2004). Such an ecosystem approach is based on the principle that resource conservation is targeted at improving the livelihoods of the poor, and works through maintaining yields of harvestable species and ecosystems, rather than the preservation of biodiversity (Adams *et al.* 2004). This has been adopted by the Convention on Biodiversity in 2000 as a strategy for the integrated management of natural resources (UNEP 2004). The snake-fishery includes a range of species, of which only one comprises the majority of the catch. It therefore follows that applying such an approach in the Tonle Sap system may result in a loss of these other rarer species, in favour of maintaining populations of the most exploitable. This situation has also been documented in the bushmeat literature and is referred to as post-depletion sustainability (Cowlshaw *et al.* 2005). It is at this point that we see a divergence from conventional conservation values.

Pro-poor Approach

There are a range of threats that face the snakes of Tonle Sap and we suggest more attention should be paid to the threats caused by the wealthier and less vulnerable households and to ultimate drivers, rather than proximate, visible threats. Poor households are often denied sufficient access to resources through economic exclusion and political disempowerment, which is considered a major factor driving poverty in fishing communities, rather than resource declines per se (Béné 2003). It has been previously documented that in recent history, the overexploitation of natural resources in Cambodia is carried out largely by the elite (military, economic and political) to the exclusion of the poor (De Lopez 2002). Many large-scale destructive activities such as the pumping of small pools and streams—an illegal practice that frequently occurs throughout the Tonle Sap floodplain—require assets not owned by the poorer households. Strategies to target these activities will impact very few households and those that likely have alternative ways to secure an income. Such strategies are politically challenging due to the power that wealth affords people, and for this reason they tend to be avoided. Equally the threat of floodplain forest loss through fires, logging and clearance for agriculture, that directly impacts the production of a range of aquatic resources (van Zalinge *et al.* 1999; Viner *et al.* 2006) needs to be addressed and will require coordination of various governance systems, including those for forestry, fisheries and agriculture (Sokhem and Sunada 2006).

As the effort to reduce the number of people living in poverty has moved forward, the conservation community has begun to incorporate sustainable use as a strategy. It is recognised that rights of access to natural resources required to sustain livelihoods are a key factor in poverty

alleviation and this has therefore entered the conservation agenda and given rise to ‘pro-poor’ strategies, designed to deliver both poverty reduction and biodiversity conservation (IUCN 2002). There is a great deal of controversy over the potential to align these goals and there has been much criticism of the disappearance of biodiversity from the global dialogue on sustainable development (Sanderson and Redford 2003; Struhsaker 1998). However, the potential for success is likely to be greater in situations such as that found on Tonle Sap, where direct benefits are derived from natural resources by poor people and where destructive practices and policies are in place that disregard both the environment and local livelihoods.

Conclusion

When considering sustainable resource use, there is a need to assess resource use activities against the backdrop of entire livelihood portfolios and possibilities, rather than through single-species conservation (or species-group in this case) by trying to manage single livelihood activities in isolation. Snake fishing is a relatively new livelihood activity carried out by those living on Tonle Sap Lake in response to market opportunities. It increases livelihood diversity and flexibility, reducing poor people’s vulnerability to resource fluctuations. While in isolation this activity is detrimental to the snake populations, interventions for sustainable hunting need to be assessed for their impact at the ecosystem and livelihoods level. Conservation strategies that strengthen, rather than erode the adaptive capabilities of resource users to cope with uncertainty, by increasing rather than restricting access should be advocated. Multi-faceted approaches are required to tackle the range of threats that are causing resource declines. Tonle Sap is facing severe resource degradation and increasing livelihood vulnerability and there is therefore a need to align conservation values with other relevant values including the eradication of poverty and sustainable development.

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