Monitoring Otter Populations and Combating Poaching Through Stakeholder Participation in India

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Country: India

Site: River Cauvery, Karnataka

Period: September 2012 – November 2014

Organization: Nature Conservation Foundation

Aim: To understand the status of otters along the River Cauvery in terms of distribution, threats and perception.

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SECTION 1

Summary

Otters are key predators of freshwater ecosystems but since most freshwater habitats lie outside the security afforded by protected areas, they face serious threats from habitat loss and modification, poaching, conflict with locals, hence leaving them highly vulnerable. Poaching, more than other threats, has contributed to severe decline in otter numbers across much of its distribution range, in this case that of smooth-coated otter, *Lutrogale perspicillata*, and small-clawed otter, *Aonyx cinerea*. The main aim of the project was to understand the distribution of otters along the River Cauvery, both inside and outside the protected area and to help combat poaching through stakeholder participation. We also proposed to map threats to otters along the entire river and to understand the factors that might influence their presence in a particular zone. We used semi-structured questionnaire surveys to understand conflict with otters and perceptions, occupancy surveys to understand percent area occupied or used by otters and modeled several habitat and disturbance covariates to learn about factors that might influence use of a particular river stretch by otters. The occupancy analysis indicates that there is no significant difference in the use of the river by smooth-coated otters between the agriculture-plains zone and the forest-protected area zone. Though this was the case, the factors identified using generalized linear models show a suite of different factors influencing the intensity of use of these two zones by smooth-coated otters. Sand mining intensity had a significant negative effect at the landscape level, along with human presence. Riparian characteristics like presence of sand banks and islands, and a riparian strip showed positive influences. The questionnaire surveys indicate that poaching of otters seems to have declined in the last 4-5 years, and fishermen report an increasing population trend for otters. Majority (80%) of them also identify otters as the primary conflict species that affects their livelihood. It is critical that we work with a diverse group of stakeholders, particularly fishermen, to change perceptions, enhance co-existence and minimize damage by extractive activities like sand mining, dynamite fishing and intensive fishing.

Introduction

In the tropics, protected areas occupy less than 10% of the total area and a substantial amount of biodiversity still exists outside (Schmitt et al., 2008). A majority of these protected areas are designated keeping large, terrestrial, charismatic species as their conservation focus. Most freshwater habitats or species are only afforded incidental protection. Freshwater ecosystems outside of protected areas are seriously threatened by land-use change and increasingly fragmentation (Saunders et al., 2002). Given the importance of river basins to agriculture and settlements, native freshwater fauna will continue to share space and be influenced by land-use practices and other human-induced changes (Saunders et al., 2002; Strayer et al., 2003) like sand mining and fishing to diversion of water for agricultural and drinking purposes. Despite this, these human-modified landscapes also serve as vital corridors for animal movement by connecting two distant or otherwise isolated protected areas (Bhagwat et al., 2008), and in landscapes lacking protected areas, these human-modified landscapes often provide critical habitats, and refuges for biodiversity (Harvey et al., 2006). Conservation of enigmatic species like otters in such a mixed use landscape is hence critical as these also encompass some of the best habitats available for them. As protected areas continue to shrink and human-modified landscapes continue to expand, conservation and research attention must be increasingly directed towards these heterogeneous landscapes, especially river basins, if we are to conserve a substantial amount of biodiversity still present in these spaces (Vandermeer and Perfecto, 2007). With studies showing the persistence of native species in human-modified landscapes (Gardner, 2009; Bhagwat et al., 2008, Sridhar et al., 2008), it becomes important to identify properties of these landscapes that enable the continued use and survival of native biodiversity (Bennett et al., 2006).

Otters are considered ambassadors of freshwater ecosystems as they are an indicator species (Mason and MacDonald, 1986) and are often the key predators where they occur (Kruuk, 2006). India is home to three species of otters – smooth-coated otter *(Lutrogale perspicillata),* small-clawed otter *(Aonyx cinerea)* and the Eurasian otter *(Lutra lutra)* (Prater, 1997; Johnsingh and Manjrekar, 2013; Menon 2014), and the presence of both smooth-coated and small-clawed otters has been well documented in the Cauvery basin (Shenoy, 2003, Shenoy et. al.,2006). Both species of otters are poached for pelt by organised otter poaching gangs, and most of the habitat being outside the network of protected areas leaves them very vulnerable to such attempts. Due to increasing poaching pressures, otters are now incredibly rare along much of South-East Asia, including parts of northern India. One of the main reasons for selecting the Cauvery is that it differs from other major rivers because it still hosts sizeable populations of otters outside protected areas. It might even be the last stronghold of the smooth-coated otter in the Indian subcontinent. In addition, it is also important to understand the perceptions of fishermen towards otters as their interaction with otters is on the rise and this might lead to problems with conflict and poaching.

The Cauvery River is one of India's major rivers, both revered and highly modified (dams, sand mining, diversions), like almost any river in the world. It flows eastwards from its origin in the hill ranges of Western Ghats through the states of Karnataka and Tamil Nadu with a total length of 765 km of which the first 330 km lies within the state of Karnataka and forms our study area. In the first 80 km, the river mostly flows through a matrix of coffee plantations, forest and paddy fields in the district of Coorg. The next 140 km of the river is through the hot and dusty Mysore plains, which is an intensively cultivated landscape with agricultural fields flanking both sides of the river. The last 110 km of the river in the state of Karnataka flows through the only major protected area along its course, the Cauvery Wildlife Sanctuary which harbours the best riparian forest along the river. There are no anthropogenic disturbances like sand mining or dynamite fishing in this stretch. Much of the river outside Cauvery Wildlife Sanctuary witnesses intensive fishing along with sand mining. There is one major dam across the river, the Krishna Raja Sagara and numerous checkdams for irrigation and an increasing number of mini-hydel projects (Fig. 1).

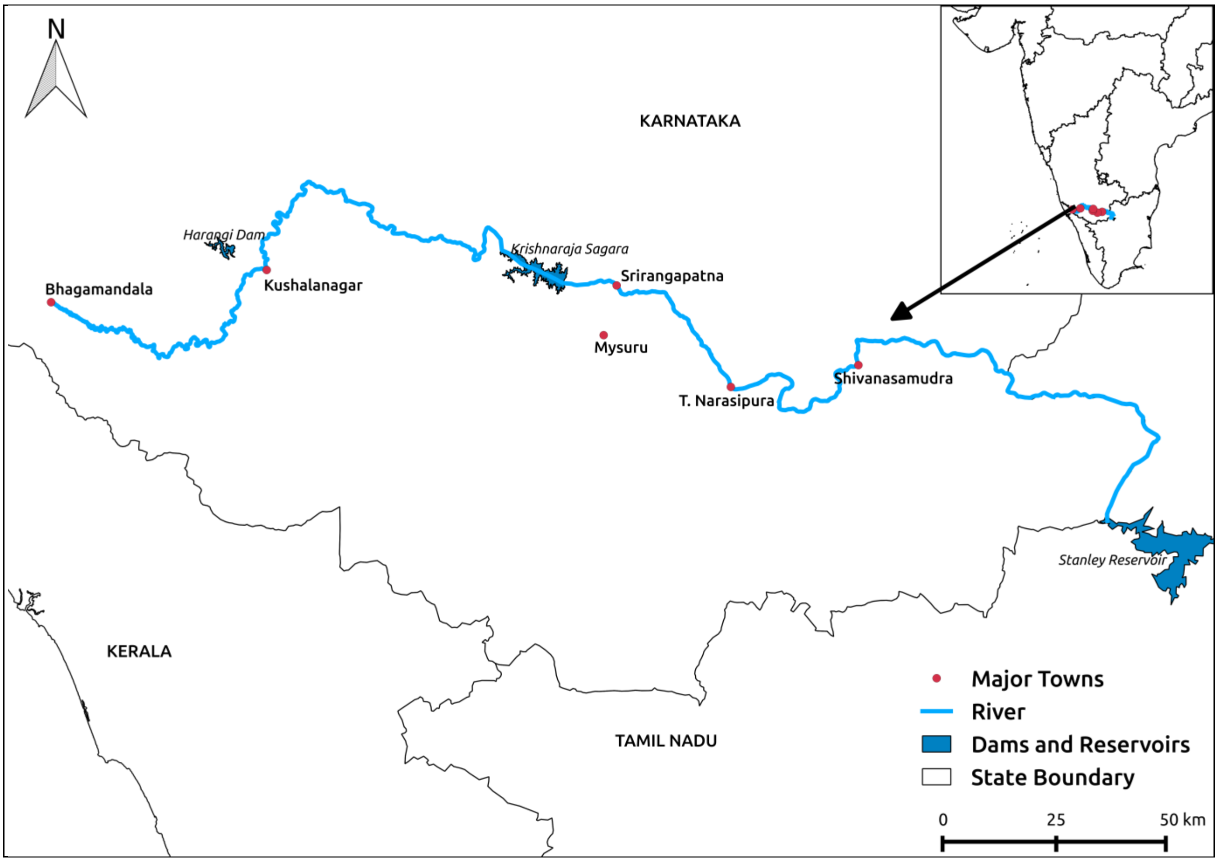

Figure 1. Study area. This map shows the section of River Cauvery that was sampled during the survey. Important towns and major reservoirs along this stretch of the river are marked in this map.

Being primarily a fish-eater, and sharing space with inland fishermen, smooth-coated otters tend to consume fish from the nets thereby causing damage to the net and leading to increasing antagonistic interactions with fishermen. In this project, we surveyed the entire stretch of the river in the state of Karnataka to understand how otters are distributed, and the factors affecting their presence and habitat use. We have mapped potential threats along the surveyed stretch and gathered information on interactions and perception of otters by fishermen. We have also analysed the occupancy (interpreted as use) of the landscape by otters and compared it across the three zones.

Key partners

Nityata Foundation is a non-governmental organisation that works on otter conservation issues. In this project they were key to our engagements with the Fisheries Department and the Coorg Wildlife Society. They also provided logistical and financial support. Inland Fisheries Department is the nodal agency that addresses fishermens' concerns and charged with conserving both livelihoods as well as freshwater sytems. Coorg Wildlife Society is a non-governmental organisation in Coorg that works along the Cauvery and works towards popularising angling as a conservation tool, particularly conservation of the gamefish Mahseer. Karnataka Forest Department is the nodal agency for protection and conservation of wildife and wild spaces. The only major protected area along the Cauvery, the Cauvery Wildlife Sanctuary is under the direct control of the forest department.

Project members

Nisarg Prakash (Team Leader, 30 years): Nisarg is a post-graduate in Wildlife Biology and Conservation from National Centre for Biological Sciences, WCS-India Programme, Bengaluru, India. Currently, he is working with Nature Conservation Foundation on otter research and conservation. He designed this project, collected data, analysed it and wrote this report.

Aathira Perinchery (27 years): Aathira also is a post-graduate in Wildlife Biology and Conservation from National Centre for Biological Sciences, WCS-India Programme, Bengaluru, India. She studied otters in the Western Ghats for her post-graduate dissertation. Presently she is a freelance science writer and director of Team Eco Ventures India Pvt Ltd. Her role was crucial in designing this study and in compiling this report.

Rajat Nayak (29 years): He completed his Masters in Wildlife Biology and Conservation from National Centre for Biological Sciences, WCS-India Programme, Bengaluru, India. Presently, he is working with a local research NGO, Foundation for Ecological Research, Advocacy and Learning (FERAL). He has a special interest in grassland ecosystems, both low and high altitude, semi-arid and wet. He has assisted with concept, data analysis and writing this report.

SECTION 2

Aims and objectives

The main aim of the project were to monitor smooth-coated otter populations both inside and outside of protected areas and to enlist the help of stakeholders to prevent poaching and conflict. We have made an attempt at understanding the distribution and use of the river by both small-clawed and smooth-coated otters, both within and outside of a protected area. In addition, we have also explored the different factors that might contribute to this pattern of use or distribution across the landscape. Among other objectives were to enumerate otter populations, map threats and evaluate type and degree of conflict with fishermen, and to verify the effectiveness of protected areas in conserving otters. In our work , we have explored the use of occupancy modelling in estimating the area under active use across the three river zones.Through this we hope to be able to compare the protected area zone with the two other non-protected zones to identify significant differences if any. However, we were unable to enumerate otters as it was not possible to arrive at a robust and meaningful estimate using the model we used. We have also mapped threats, particularly sand mining, poaching and dynamite fishing across the entire unprotected stretch. Through our semi-structuredquestionnaire surveys we also investigated the issue of conflict with otters and have presented our preliminary findings.

Methods

We examined the influence of several habitat covariates on the occupancy and intensity of habitat use of otters along the River Cauvery in the state of Karnataka, in a landscape dominated by human-modified areas, with only a protected area towards the end. The field sampling was carried out from September 2012 to June 2014 with most fieldwork happening in the summer months/ low water season, as it is an ideal time to sample for otter signs (Fusillo et al., 2007).

Study design

River zones

The entire rive was broadly classified into three zones – the Forest-Plantations zone in Coorg, the Agriculture-Plains zone which encompassed parts of Hassan, Mysore and Mandya districts and the Forest-Protected Area zone which encompassed the entire Cauvery Wildlife Sanctuary.

Forest-Plantations (Zone A) – We sampled 46 km of the river in this zone which wholly encompassed the hilly district of Coorg. This zone is characterised by a mosaic of coffee plantations, paddy fields and forest patches lining the course of the river. The river originates in the Western Ghats at Talacauvery and flows eastwards through the district (Fig. 2).

Figure 2. River in Zone A - good riparian cover

Agriculture-Plains (Zone B) – We sampled 72 kilometers of river in this zone which mostly encompassed parts of Hassan, Mysore and Mandya districts. This zone is characterized by flat terrain, and intensive agriculture. Extraction of sand is carried out on an industrial scale in this zone and is mostly meant for far away markets (Fig. 3).


Figure 3. River in Zone B - low riparian cover and sand mining


Figure 4. River flowing through Cauvery Wildlife Sanctuary- Zone C

Forest-Protected Area (Zone C) – We sampled 55 kilometers of the river within the Cauvery Wildlife Sanctuary. The river in the wildlife sanctuary differs from the other two zones in the fact that very few of the disturbances measured in the other zones exist here. There is no sand mining and intensive fishing within the sanctuary limits. The zone is characterized by continuous riparian forest (Fig. 4).

Otter surveys

Our field survey was spread across two summers - 2013 and 2014. We conducted the survey using multiple modes depending on the site and logistics, and surveyed either bank for a number of habitat and disturbance covariates. Among modes of survey apart from being on foot were use of a coracle (a local fishing vessel made from bamboo), inflatable raft and kayak as the study design entailed switching banks every kilometer.

We systematically surveyed 173 river transects of length 1 km. The entire river was first divided into 1km transects, with each of these 1 km transects being further sub-divided into 200m segments. We sampled every alternate 1km transect and switched banks with each new 1km transect. At every 200m in this 1 km selected transect, we recorded a suite a habitat and disturbance covariates that might influence otter presence and use. Presence of otter signs wherever they occurred were measured throughout the transect. Indirect signs considered were spraint, footprint, tail drags and grooming sites. Direct sightings were recorded wherever observed. Indirect signs were classified as either belonging to small-clawed otters or smooth-coated otters based on certain characteristics such as presence of webbing in footprints, claw impressions and overall appearance. Similarly, spraints were characterised as belonging to either species based on content, appearance, and habitat. Otter signs were also geo-tagged using a GPS.

Quantification of riparian habitat

We measured a number of variables we thought might influence otter presence and use of a particular stretch. The variables measured were sand bank presence, presence of islands, sand mining intensity and presence of sand mining, number of trees per km, undergrowth density, riparian strip width, river width and human presence. The banks were searched for otter signs, and the signs recorded were footprints, spraint, and tail drags or grooming sites, in addition to direct sightings.

Density of undergrowth was measured using a graduated stick with bars showing at every 25 cm. Number of bars visible at 0, 5 and 10m from the water's edge were recorded and a score computed as a proxy for undergrowth density. Higher the score lower the undergrowth density. Similarly, number of trees were recorded in a 5m radius from the water's edge, and classified as belonging to 30 to 50 cm, 50 to 100cm or greater than 100 cm girth categories. Disturbances recorded were sand mining, dynamite fishing, presence of water pumps and tourism, and each of these was recorded for every 200m segment. River width was measured at every 200m sampling point using a laser rangefinder. Presence of sandbanks and islands were recorded for every segment. We also used an android mobile-based platform to record otter signs and disturbances during the course of the study. Presence of sand mining was recorded, and visually categorised as being low, medium or high. These intensity levels were then used to factor sand mining – multiplying by 1 for low, 2 for medium and 3 for high to derive intensity scores. Presence of sand mining was also recorded as a covariate for analysis. Human presence was computed by combining scores from both settlements and tourism.

Semi-structured questionnaires

We interviewed 156 respondents belonging to 80 villages along the river (Fig. 5). 109 of these respondents were people who practised fishing for livelihood, and the other 47 were other stakeholders like farmers, labourers, coffee planters and part-time fishermen who all interacted/ used with the river frequently.

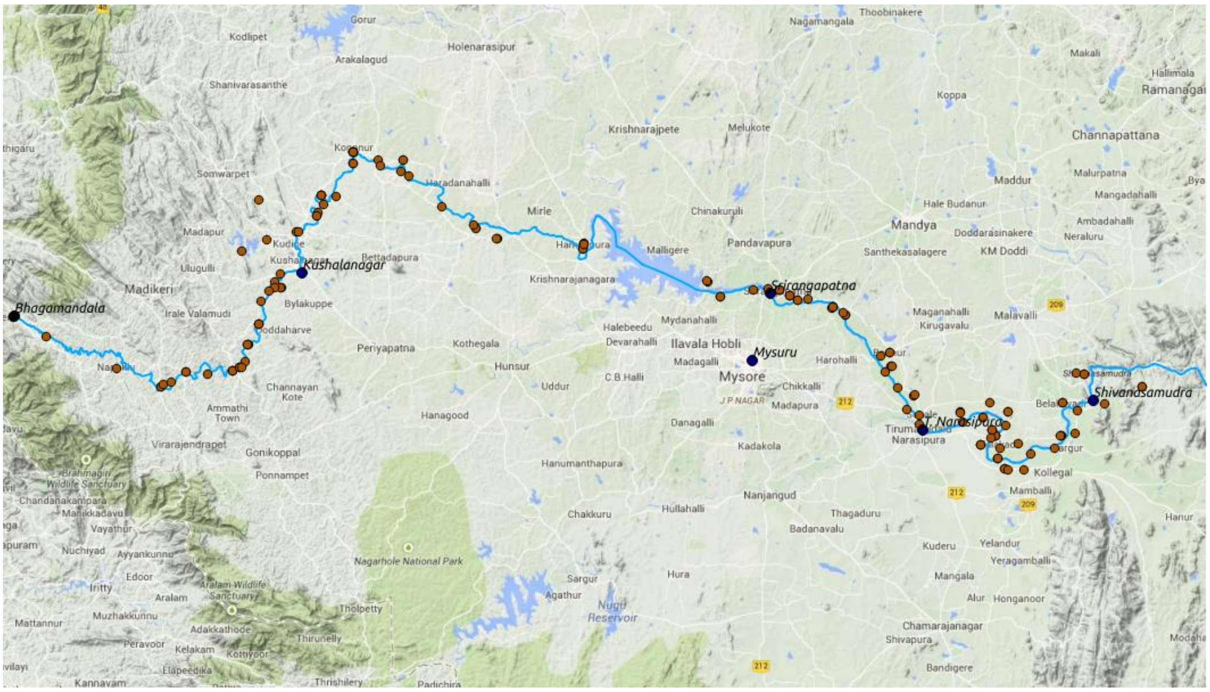

Figure 5. Location of villages where interviews were conducted.

Data analysis

Analysis was carried out by three zones and two species, combining species in some cases to get an overall picture.

Signs – We used total number of otter signs in each zone to compute encounter rates and naive occupancy.

Occupancy – We constructed detection histories for each river transect depending on whether otter signs were detected or not detected in each of the five segments within a transect . This was then analysed in the occupancy framework (Mackenzie et al., 2002) using PRESENCE version 7.3 (Hines, 2006), for each zone separately and combined.

Habitat variables were summarised as follows. Average of averages to estimate parameters as mean ± SE for each zone, taking transects as replicates. We tested for difference among zones using ANOVA.

Based on a correlation matrix of all the measured or estimated variables, we eliminated those that were highly correlated with one or more other variables. Generalised Linear Models

(GLMs) were then used to model otter habitat-use, using number of spraints as an index of intensity of otter habitat-use (Mason and Macdonald, 1987). Since we used the number of spraints (count data) as an indicator of intensity of habitat-use, we used quasi-Poisson family of distributions in the generalised linear model (GLM). The global model was run through the model simplification process and non-significant variables were eliminated based on their deviance and P values. One variable was dropped at each stage of the model simplification process until only significant variables were remaining (Crawley, 2005). Then, QAIC scores were computed and the model with the lowest QAIC score selected as the final model. All analysis was carried out using software RStudio Version 0.98.1049.

Results

Camera traps pictures and sightings in the field showed the presence of two species of otters in the sampled area. They were the Oriental small-clawed otter and smooth-coated otter in Zone A and only the smooth-coated otter in Zones B & C.

Figure 6. Smooth-coated otters, *Lutrogale perspicillata,* at a den in the Agriculture-Plains zone

Figure 7. Small-clawed otter, *(Aonyx cinerea)* in the Forest-Plantations zone.

Otter distribution and relative abundance

We obtained 148 sign detections and 22 sightings of otters during the study (Fig. 8). Small-clawed otters were sighted twice, and smooth-coated otters were sighted twenty times during the survey.

Forest-Plantations – Otter presence was detected in 24 of the 46 transects in the Forest-Plantations zone. The encounter rate for signs was 0.87 signs/ km. We also had two sightings of small-clawed otters, once a single otter and three otters the second time. All signs encountered in this zone were those of small-clawed otters, with only one sighting of smooth-coated otters in the entire 46 km covered. No signs of small-clawed otters were encountered beyond the Forest-Plantation zone, i.e., in Agriculture-Plains and Forest-PA zone (Table 1).

Agriculture-Plains – 26 out of 72 transects had evidence of smooth-coated otters using them. The encounter rate for signs was 0.68 signs/km. We had two sightings of smooth-coated otters during the survey, one consisting of a pack of 11 otters and the other a pack of 5 otters (Table 1).

Forest-Protected Area – 28 of the 55 transects surveyed had evidence of otter signs and the encounter rate was 1.31 signs/ km. We sighted smooth-coated otters five times, with pack size ranging from two to 10 animals. (Table 1)

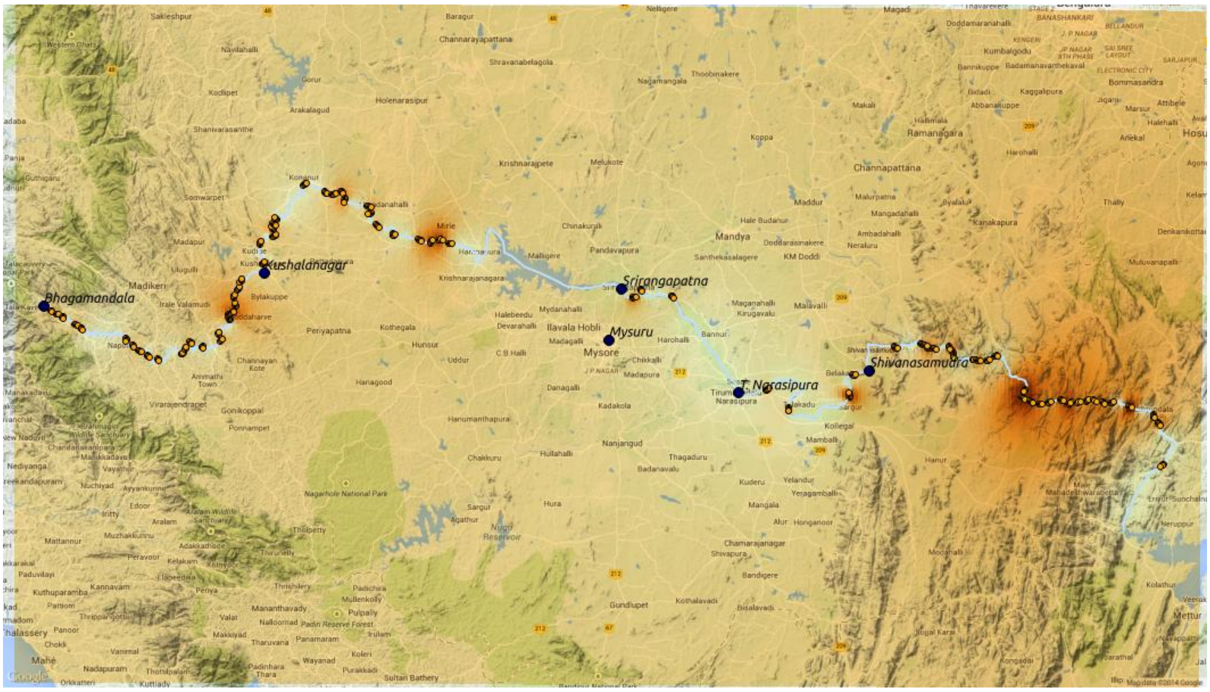

Figure 8. Distribution of otter signs along the river, the dark areas indicate a higher density of otter signs.

Table 1. Characteristics of three zones sampled and otter signs/sighting statistics for each zone.

	Forest-Plantations	Agriculture-Plains	Forest-PA
Length of the river sampled	46 km	72 km	55 km
Small-clawed otter			
% occurrence	52	0	0
Abundance index (No. of signs/ km)	0.87 signs/ km	0	0
Sightings	2	0	0
Smooth-coated otters			
% occurrence	0	36	51
Abundance index (No. of signs/ km)	0	0.68 signs/ km	1.31 signs/ km
Sightings	1	15	5
Both species			
% occurrence	*45*		
Abundance index (No. of signs/ km)	*0.93 signs/ km*		
Sightings	*23*		

Table 2. Occupancy (to be interpreted as otter use) estimates for different land use types.

Zone	Species	Model	Naive estimate	Occupancy	SE	Detection probability *(p)*	SE
Forest-Plantation (Zone A)	*A. cinerea*	Single season, constant P	0.52	0.77	0.1531	0.20	0.0481
Agriculture -Plains (Zone B)	*L. perspicillata*	Single season, constant P	0.36	0.58	0.1316	0.18	0.0448
Forest-PA (Zone C)	*L. perspicillata*	Single season, constant P	0.51	0.57	0.0802	0.35	0.0471
Overall	*Ac + Lp*	Single season, constant P	0.45	0.58	0.0589	0.25	0.0277

Occupancy (to be interpreted as otter use)

Overall – We surveyed 173 transects, and otter signs were detected in 78 transects resulting in a naive occupancy estimate of 0.45. With occupancy *(ψ)* and detection probability *(p)* held constant, the probability of otter occupancy for the entire surveyed landscape was 0.58 ± 0.0589 with an estimated overall *p* of 0.25 ± 0.0277 (Table 2). Since a major aim of the study was to investigate the influence of land-use on otter occurrence, occupancy was estimated separately for each zone – forest-plantations, agriculture-plains and protected area.

Forest-Plantations – Otter signs were detected in 24 of the 46 transects surveyed resulting in a naive occupancy estimate of 0.52. With occupancy *(ψ)* and detection probability *(p)* held constant, the probability of otter occupancy for the zone was 0.77 ± 0.1531. The detection probability was found to be 0.20 ± 0.0481. (Table 2)

Agriculture-Plains – Otter signs were detected in 26 of the 72 transects surveyed resulting in a naive occupancy estimate of 0.36. With occupancy *(ψ)* and detection probability *(p)* held constant, the probability of otter occupancy for the zone was 0.58 ± 0.1316 with an estimated detection probability of 0.18 ± 0.0448. (Table 2)

Forest-Protected Area – Otter signs were detected in 28 of the 55 transects resulting in a naive occupancy estimate of 0.51. . With occupancy *(ψ)* and detection probability *(p)* held constant, the probability of otter occupancy for the zone was 0.57 ± 0.0802 with an estimated detection probability of 0.3555 ± 0.0471. (Table 2)

Differences among zones in habitat characteristics

Riparian habitat and threats

Based on a correlation matrix, we selected variables that were not correlated. The selected variables were presence of sandbank, presence of islands, sand mining intensity, number of trees per km, river width, undergrowth density, human presence and riparian strip width. A one-way ANOVA was performed on this subset of unrelated covariates to examine differences across the three zones.

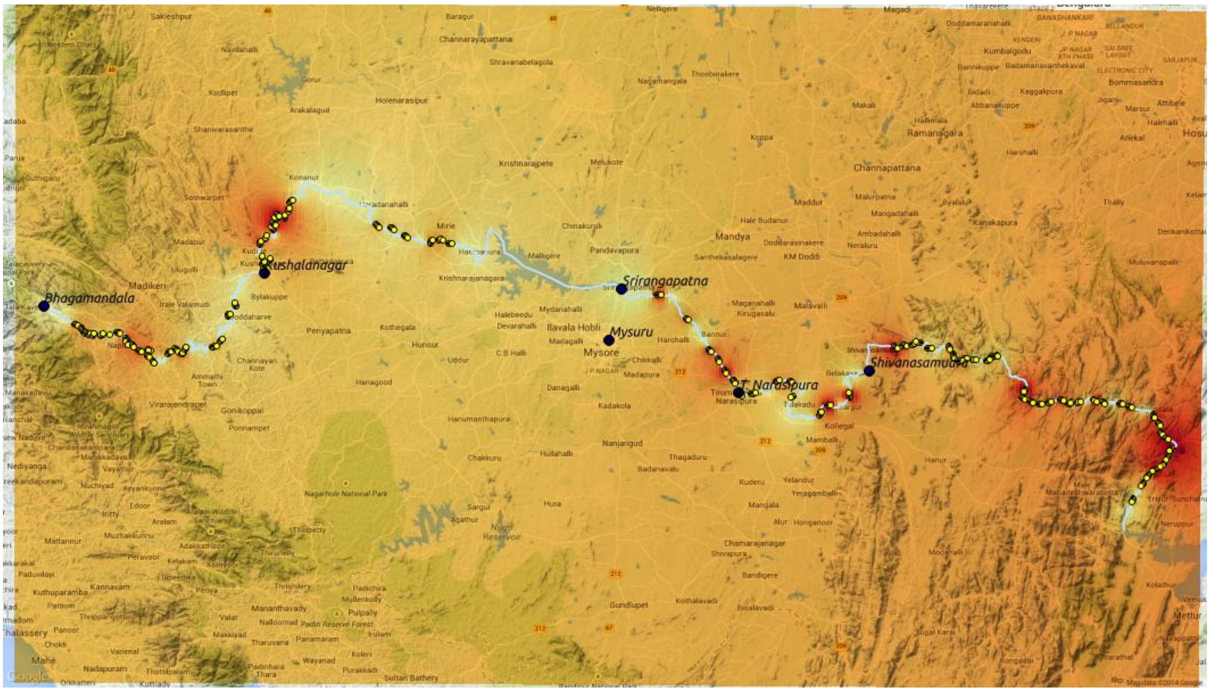

Figure 9. Distribution of sand banks along the river. The darker areas are transects with sand banks in more than four segments.

Table 3. Variation in riparian habitats and threats along the River Cauvery. Tabled values are mean (SE), for details see Methods.

Variable	For-Pln (A)	Agri-Plains (B)	For-PA (C)	P-value
Sandbank (average)	0.94 (0.1656)	1.07 (0.1772)	1.73 (0.2356)	0.0148
Islands (average)	1.44 (0.2360)	2.64 (0.2178)	2.09 (0.2675)	0.0028
Sand-mining (sum)	88 (0.2081)	109 (0.1519)	0	2.63e-16
Sand-mining intensity (score)	2.91 (0.4492)	3 (0.5158)	0	5.12e-07
No. of trees (sum)	4.80 (0.7787)	3.25 (0.5069)	4.61 (0.7413)	0.166
Undergrowth density (average)	6.37 (0.3719)	8.86 (0.3947)	13.18 (0.2594)	<2e-16
Riparian strip width (average)	12.11 (0.5389)	12.60 (0.6715)	97.16 (1.833)	<2e-16
River width (m, average)	49.16 (4.7842)	151.33 (10.008)	152.73 (5.6483)	<2e-16

Among the river characteristics measured, the ANOVA showed that presence of islands and river widths were significantly different across the three zones. Similarly, the disturbance variable sand mining intensity showed significant difference across the two zones where it is present (Table 3).

Among the riparian habitat/ bank characteristics measured, presence of sandbanks, undergrowth density and riparian strip width were significantly different across the three zones, but number of trees per km was not significantly different (Table 3).

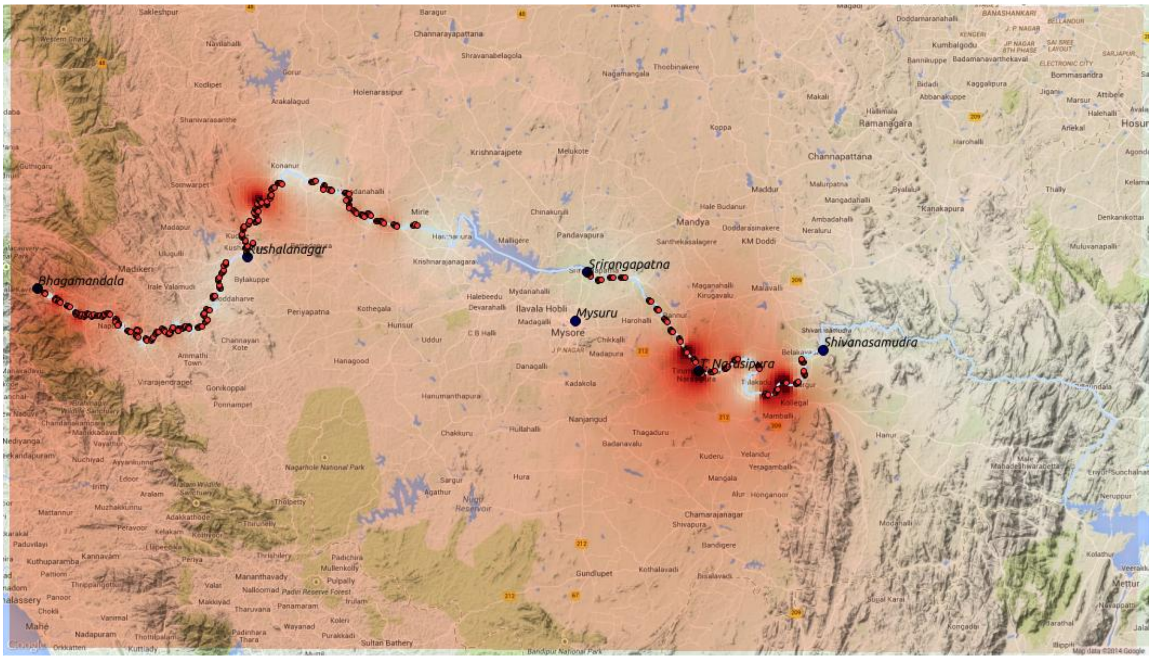

Figure 10. Intensity of sand mining hotspots along the Cauvery. Red dots indicate presence of sand mining.

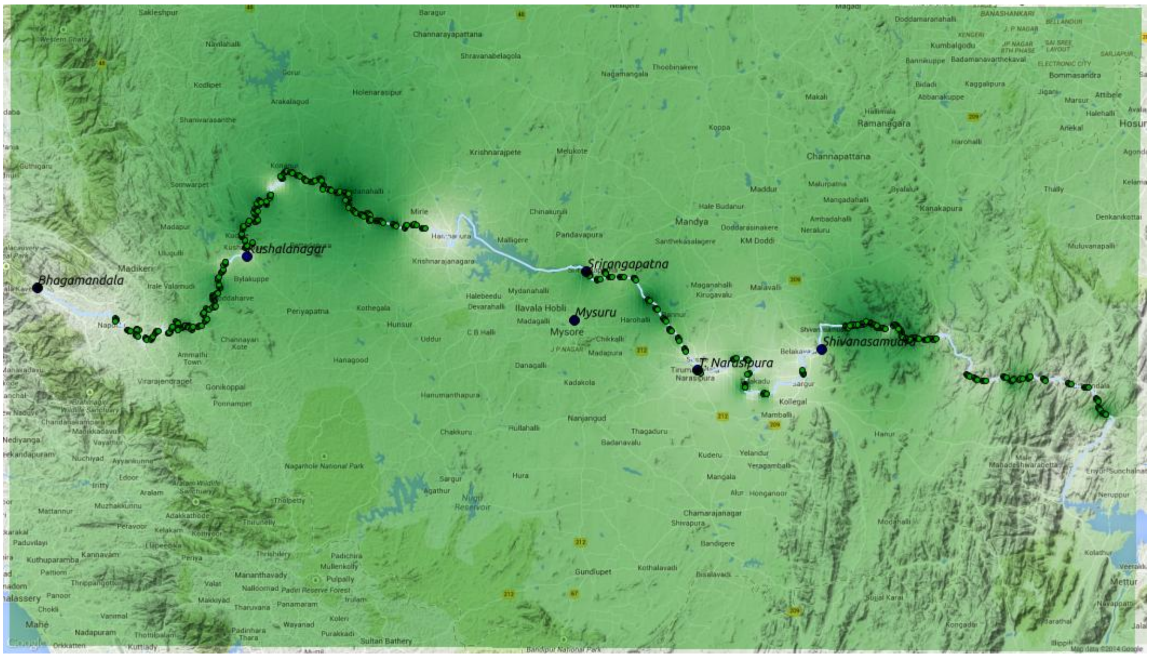

Figure 11. Distribution of transects with islands. Green dots indicate presence of islands in the particular segment.

Habitat-use

A total of 148 otter signs were detected in the 173 transects covered during the survey. In addition to that, we also sighted otters 22 times during the course of the survey. Encounter rates were highest within the Forest-PA zone followed by the Forest-Plantation zone and the Agriculture-Plains zone. The encounter rates were 1.31, 0.87 and 0.68 signs per km respectively.

We used generalised linear models (GLMs) to model habitat-use of otters as a function of various habitat and disturbance covariates. A candidate set of covariates already screened for collinearity was used to construct the global model. The covariates included in the global model were presence of sandbank, presence of islands, sand mining intensity, number of trees per km, river width, undergrowth density, human presence (combination of settlements and tourism) and riparian strip width. We used GLMs to model overall habitat use and in all three zones. The global model remained the same across all three zones.

Global model

Otter signs-count ~ Sand mining intensity + presence of sandbank + Undergrowth density + River width + Riparian strip width + No. of trees per km + presence of islands + Human presence

All zones

Final model selected – Otter signs count ~ Zone + Sand mining intensity + presence of sandbank + River width + riparian strip width + presence of islands + Human presence

Table 4. Summary of model simplification and QAIC scores.

Model	Non-significant parameter dropped	Deviance	(Null dev-Resid. dev)/ Null dev	QAIC
Global model	-	253.53	0.17	291.4209
M2	Undergrowth density	253.59	0.17	290.8259
M3	Number of trees/ km	254.41	0.17	286.0389
M4	Human presence	256.82	0.16	290.1287
M5	Riparian strip width	265.44	0.14	288.0031
M6	River width	274.48	0.12	293.6946
M7	Islands presence	278.48	0.11	290.7036

In the overall model, which was across the three zones the model selected based on QAIC scores included river zones, sand mining intensity, presence of sandbanks and islands, river width, riparian strip width and presence of humans (Table 4). The Δ QAIC between the Global model and the final model was 5.38. There was a strong negative relationship with sand mining intensity and was significant at the 0.05 level. Presence of sand bank showed a strong positive relationship and was significant at the 0.05 level. The other non-significant variables in the final model included zone, river width, riparian strip width, presence of islands and humans (Table 5).

Table 5. Table 5: Summary statistics for the final model across all the zones after model simplification & QAIC.

	Estimate	SE	t value	*P*
(Intercept)	-0.404023	0.476830	-0.847	0.39808
Zone B	-0.180308	0.340551	-0.529	0.59722
Zone C	-2.719857	2.478451	-1.097	0.27410
Sand mining intensity	-0.126318	0.058280	-2.167	0.03167
Sandbank presence	0.206783	0.068061	3.038	0.00278
River width	-0.002741	0.002367	-1.158	0.24841
Riparian strip width	0.033622	0.027944	1.203	0.23066
Islands presence	0.085306	0.058153	1.467	0.14435
Human presence	-0.188802	0.166425	-1.134	0.25829

Forest-Plantations

Final model selected – Otter signs count ~ presence of islands + Human presence

Table 6. Summary of model simplification and QAIC scores for otter signs count in zone A.

Model	Non-significant parameter dropped	Deviance	(Null dev-Resid. dev)/ Null dev	QAIC
Global model	-	46.815	0.27	108.9634
M2	Riparian strip width	46.832	0.27	109.4342
M3	River width	46.868	0.27	110.3588
M4	Number of trees/ km	47.307	0.26	108.4639
M5	Sand-mining intensity	48.874	0.24	103.9612
M6	Sandbank presence	50.366	0.21	104.287
M7	Undergrowth density	52.546	0.18	101.3695
M8	Islands presence	54.574	0.15	107.9674

For the Forest-Plantations zone, the model selected included presence of islands and humans. Presence of humans had a positive relationship and was significant at the 0.05 level. The ΔQAIC between the global model and the final model was 7.59 (Tables 6 & 7).

Table 7. Summary statistics for the final model after model simplification & QAIC in zone A.

Parameters	Estimate	SE	t value	*P*
(Intercept)	-0.5927	0.2694	-2.200	0.0332
Islands presence	0.1486	0.1083	1.372	0.1772
Human presence	0.6840	0.2845	2.404	0.0206

Agriculture-Plains

Final model selected – Otter signs count ~ presence of sandbank + undergrowth density + No. of trees per km

Table 8. Summary of model simplification and QAIC scores in zone B.

Model	Non-significant parameter dropped	Deviance	(Null dev-Resid.dev)/ Null dev	QAIC
Global model	-	69.424	0.37	129.9039
M2	Human presence	69.431	0.37	130.0711
M3	Islands presence	69.445	0.37	130.3804
M4	River width	70.324	0.37	131.0188
M5	Riparian strip width	79.326	0.30	125.0097
M6	Sand mining intensity	83.775	0.27	109.8251

In this zone, the final model included presence of sand banks, undergrowth density and number of trees per km with all three variables being significant at the 0.05 level. All three variables also showed a strong positive relationship with the response variable. The ΔQAIC between the global model and the final model was 20.08 (Tables 8 & 9).

Table 9. Summary statistics for the final model after model simplification & QAIC in zone B.

Parameters	Estimate	SE	t value	*P*
(Intercept)	0.24257	0.44020	0.551	0.583417
Sand bank pres	0.42734	0.11920	3.585	0.000629
Undergrowth density	-0.20141	0.05758	-3.498	0.000832
No. of trees/ km	0.11489	0.03862	2.975	0.004057

Forest-Protected Area

Final model selected – Otter signs count ~ presence of islands + River width

Table 10. Summary of model simplification and QAIC scores in zone C.

Model	Non-significant parameter dropped	Deviance	(Null dev-Resid. dev)/ Null dev	QAIC
Global model	-	87.111	0.27	108.432
M2	Riparian strip width	91.434	0.23	106.2445
M3	Number of trees/ km	91.446	0.23	106.2785
M4	Undergrowth density	91.527	0.23	105.9558
M5	Sandbank presence	92.819	0.22	104.2555
M6	Human presence	95.563	0.19	99.58273

In this zone, the final model included presence of islands and river width as best predictors. River width was highly significant at the 0.05 level and showed a strong negative relationship. The ΔQAIC between the global model and the final model was 8.85 (Tables 10 & 11).

Table 11. Summary statistics for the final model after model simplification & QAIC in zone C.

Parameters	Estimate	SE	t value	*P*
(Intercept)	2.120121	0.550965	3.848	0.000333
Islands presence	0.156713	0.087367	1.794	0.078784
River width	-0.015160	0.004328	-3.503	0.000966

Semi-structured questionnaire surveys

Of the 156 respondents belonging to 80 villages, 109 were full-time fishermen, while the rest were other stakeholders but who interacted with the river frequently.

104 out of the 109 fishers interviewed used factory-made gill nets as their primary gear compared to hand-woven nylon nets in the previous generations.

Otters as primary conflict species – 100 out of the 156 respondents we interviewed identify otters as the primary conflict species (Fig. 12). Of the 100, 88 respondents were fishermen which accounts to 80% of all fishermen (n=109) interviewed. The other animals associated with conflict were the mugger, cormorants, crabs, turtle and the water snake.

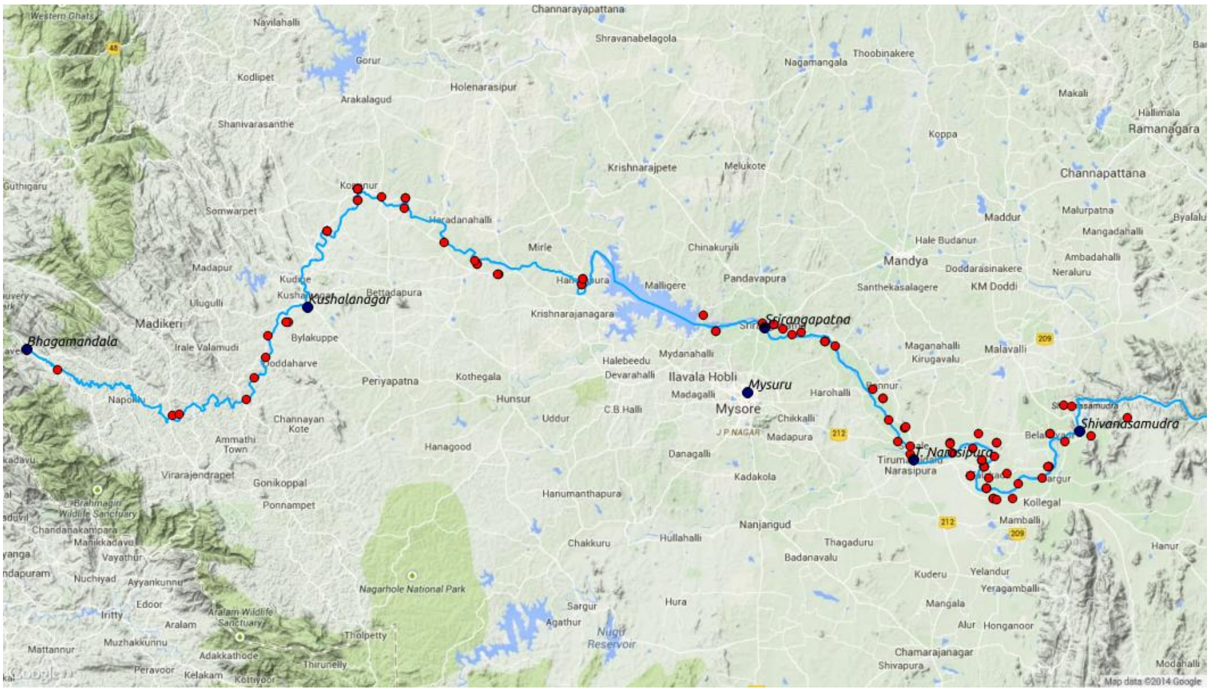

Figure 12. Location of villages where fishermen perceive the otter to be the primary conflict species.

Otter population trend – 81 of the 109 fishers (74.3%) interviewed strongly believe/ perceive otter numbers to have risen in the last 5-10 years, and only 15 in the 109 (13.7%) seem to indicate that otter numbers might have declined. In the non-fishers category, only 16 of the 47 (34%) respondents indicate that otter numbers have risen, while 20 of the 47 (42.5%) say otter numbers have declined in the preceding 5 years.

Fish catch trend – 127 of the 156 (81.4%) respondents claim a decline in fish catch in the last few years. Amongst fishers, 102 of the 109 (93.5%) report a decline while only 25 of the 47 (53.2%) non-fishers report a decline.

Fish stocks in the river - 68 of the 109 fishers strongly believed that there was not sufficient fish in the river for both otters and fishermen while 34 of the 109 believed there was. When we compare this with non-fishers, 15 of the 47 believe there was not sufficient fish while 11 of the 47 believed there were.

Poaching – 61 of the 109 fishers interviewed were aware of otter poaching incidents along their stretch of the river (Fig. 13). Overall, 81 of the 156 respondents were aware of otter poaching incidents in the past in their stretch of the river. Otter poaching incidents recorded ranged from those that were 2 to 3 years old to those that were more than 15 years old.

Dams and fishing – A total of 33 people responded to this question on whether fish catch has declined after the dam in vicinity was constructed. 27 of the 32 fishers who responded reported a decline in fish catch after construction of the dam. The dams in question are mini-hydel projects constructed in the last 15 years by modifying a portion of existing, old, irrigation check-dams.

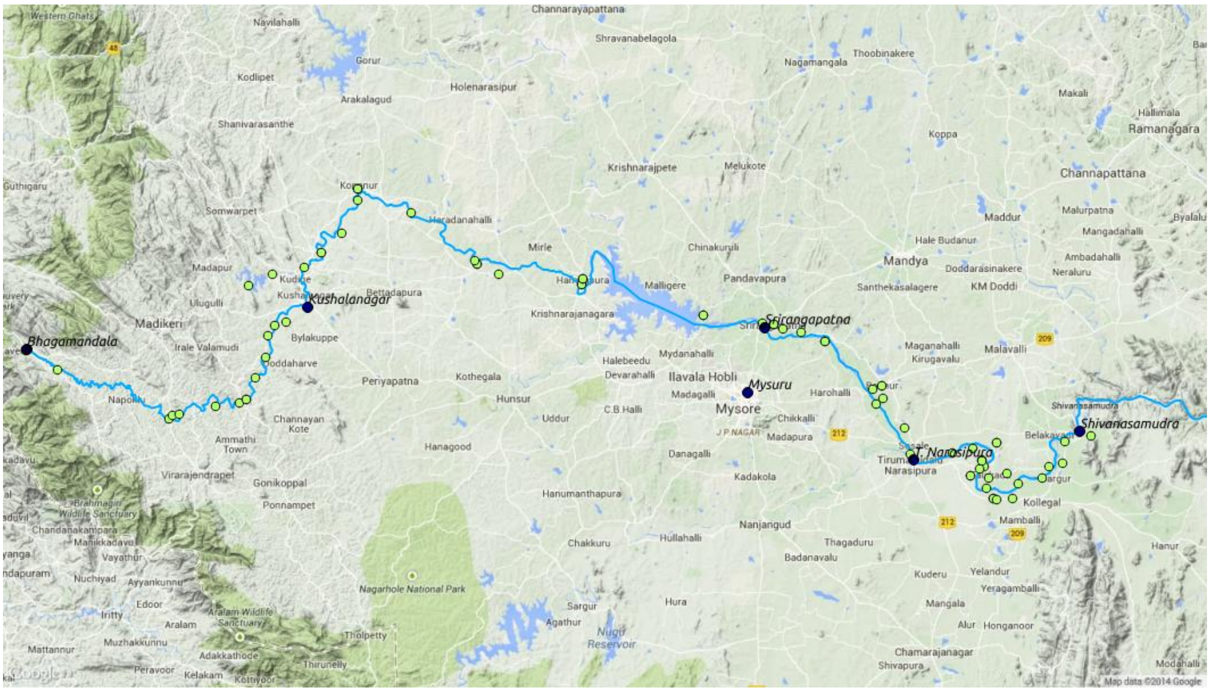

Figure 13. Map of poaching incidents along the river, obtained from questionnaire surveys

Achievements and Impacts

Occupancy results indicate there is no significant difference in otter use between the protected area zone and the agricultural plains zone. It would be very hard to draw inferences while comparing otter use in protected area and the zone outside as the occupancy estimate is almost the same. The results also indicate that small-clawed otter occupancy is high (nearly 75%) as compared to smooth-coated otter occupancy in the respective zones (nearly 57%). Detection probability was higher in the protected area as compared to non-protected zones. This could possibly be because the survey within the protected area was conducted on foot and not by raft/kayak like in the other zones. In addition, the presence of more sand banks, rocks and lower undergrowth density in the protected area might make detecting otter signs easier as compared to the other zones.

Since the three zones are very different in characteristics and protection regimes, it is important to understand the factors that might influence the intensity of use by otters of the riverscape. As seen in the analysis, though occupancy (interpreted as use) did not differ significantly across zones B & C, the factors influencing intensity of otter use differed significantly. Both zones B & C have smooth-coated otters while zone A has the presence of only small-clawed otters. Disturbances like sand mining and dynamite fishing varied significantly across zones B & C. Intensive fishing and sand mining were absent in zone C, as were settlements. The sanctuary though has tourism facilities and shrines scattered along the course of the river.

Overall (all three zones): At the landscape level, not differentiating between species, the model selected a mix of riparian, river and disturbance covariates. Sand mining modifies riverbanks and the riparian habitat structure significantly. It also amplifies disturbance by bringing in a large labour force (human presence) and with constant activity in the river channel. Smooth-coated otters are thought to be diurnal in nature and heavy activity along the river during the day such as mining of sand or other human activity might negatively influence the use of the area by otters. River width too had a negative correlation. The intensity of use was positively correlated with presence of sand banks (significant) and islands, and with riparian strip width. Sand banks are extensively used by otters as grooming and basking sites and might be a very important feature in otter habitats. Riparian strip width though not being significant might be an important feature in human-modified landscapes as it acts as a buffer between the river and surrounding land-use, thereby minimizing disturbance, and proving cover to the animals. We expected this to be a significant covariate but were to be proved otherwise. This covariate was still retained in the model selected based on QAIC scores. Presence of islands in a particular stretch might prove to be an important factor as it could provide safe denning sites and refuges especially when inaccessible from the banks and overgrown.

While the overall analysis combined all three zones and identified covariates that might influence otter use of a particular area, we were interested in the effect of land-use zones on otter use.

Forest-Plantations zone: River characteristics in this zone, the initial 80 km of river are significantly different from the other zones downstream. The river is narrow with an average width of nearly 50 m as compared to the 150 m in the other zones. The model selected based on QAIC scores retained presence of islands and human presence (significant) as factors influencing count of signs. We detected the presence of only small-clawed otters in this zone during the survey. Earlier surveys and existing literature (Prakash et. al., 2012) indicate that small-clawed otters are mostly nocturnal in habit in contrast with the smooth-coated otters. Considering this piece of information, use of the river near settlements after dark might be a way of avoiding active disturbance along the banks. Islands can provide important resting and denning sites.

Agriculture-Plains zone: This zone almost wholly encompasses the river in the plains, with intensive agriculture on both banks. This zone has only the presence of smooth-coated otters. The QAIC selected model for this zone included presence of sand banks, density of undergrowth and number of trees per km covariates in a positive correlation with intensity of otter use. Presence of sand banks might be a very important factor to highly social, pack-living animals like the smooth-coated otters. Sand banks are often used as grooming sites by otters and usually see a high incidence of visits from indirect signs left behind. This zone also has intensive sand mining and fishing, and due to these forms of disturbance, covariates such as undergrowth density and number of trees per km might be critical for the species. Like mentioned earlier, high undergrowth density provides good cover for resting and denning, and also acts as a buffer between the surrounding land-use and the river. Riparian trees are often important to otters as otters are known to dig holts under the network of tree roots and these sites continue to be used repeatedly. Having high density of undergrowth, more number of trees and larger riparian strip width increases the diversity of riverside habitats.

Forest-Protected Area zone: The final stretch of the river is through the only major protected area, the Cauvery Wildlife Sanctuary. There exists an almost unbroken stretch of riparian forest, and the river is rocky and flows through a mostly undulating terrain. The model selected based on QAIC scores retained river width (significant) and presence of islands as important covariates. River width, again, shows a negative correlation with intensity of use by otters similar to the final model in the overall category.

Impacts –We now have a network of fishermen to watch for incidents of otter poaching. In two particular stretches, one upstream of the dam and one downstream, which have good otter populations, we have monitored fish catch and antagonistic interactions as part of a follow-up project. Preliminary information from this project was used to plan a more community-oriented project. We also know the factors affecting otters in a particular zone and can build upon this information if we plan the next project.

Figure 14. An active otter den under tree roots of a Ficus sp.

Section 3

Conclusion

We primarily divided the Cauvery into three zones based on land-use practices to assess the influence of land-use on the occupancy (interpreted as use) of the zone by otters. In addition, we also identified factors that influence their intensity of use of a particular zone. The factors identified were markedly different for the zones and overall. Occupancy was not significantly different for the two zones with smooth-coated otters despite highly different protection regimes and disturbances, while in zone A, the only zone with presence of small-clawed otters, occupancy was markedly higher. The factors that influence intensity of a use of a particular zone varied across the three zones, and at the overall landscape level. Sand mining intensity which we mapped across the entire river, turned out to be negatively correlated with intensity of use by otters, at the landscape level while sand bank presence had a strong positive effect. Presence of islands, which could also act as refuges for otters, was a significant positive effect and was present in three of the four models. Sand bank presence, undergrowth density and number of trees per km all had a strong positive effect on intensity of use in the agriculture-plains zone indicating the importance of unmodified riverbanks with good riparian vegetation, that acts as a vital buffer between the river and surrounding land use. The semi-structured questionnaire survey indicate that otters are seen as the primary conflict species by more than 60% of people interviewed, and 80% of the fishermen interviewed. At the same time, more than 90% of fishermen reported declining fish catch and with increasing otter numbers (reported by more than 70% of fishermen interviewed), we foresee an increase in antagonistic interactions between otters and fishermen. From our interviews, we know that poaching which has played a big role in eliminating otter populations from many other river basins seems to be on the decline along the Cauvery. While trying to understand more about the ecology of the smooth-coated otters in human-modified landscapes, it is also essential that we engage with our primary stakeholders (fishermen) and work with them to change perceptions of conflict through a combination of dialogue, data and science.

Problems encountered and lessons learnt

In the face of competition for the same resource i.e., fish, by both otters and fishermen, our central theme of working with fishermen to conserve otters did not proceed as expected. The incidence of antagonistic interactions with otters is high (see map) across the river zones 80% of the fishermen interviewed ranked otters as the primary conflict species that affected their livelihood. They also perceive an increase in otter populations in the last 5 years and this could potentially lead to a situation where otters are blamed for declining fish catch and livelihoods. Working long term with fishermen and engaging in constant dialogue and collaboration can potentially help mitigate these threats.

Poaching was initially thought to be the primary driver of otter decline along the river. From our interviews and interaction with fishermen, we learnt that though poaching for pelt has occurred along the river in the past, the trend has shown a sharp decline and there are no new reports. Otter poaching was mainly carried out by organised poaching gangs specialised in trapping otters. These people would often visit river stretches, camp and set up traps after ascertaining the presence of otters. In fact, many of the fishermen we interviewed report an increase in otter populations after the decline in otter poaching which bodes well for us. We found antagonistic interactions with otters more worrisome as this has the potential to lead to retaliatory killing by fishermen. This antagonistic interaction is a synergistic effect and caused by a number of issues such as sand mining, dynamite fishing, declining fish catch, an increase in the number of fishermen, etc.

Mapping distribution of otters across the river zones, mapping threats and the semi-structured questionnaire surveys mostly progressed as planned, except for the delay caused by the dry spell. The survey, which was initially planned for a year (2012-2013), had to be split over two summers because of an extreme dry spell, which led to the river completely drying up the first year.

In the future

A future enhancement to this project would be to work more intensively in a shorter river stretch, which incorporates all elements of the riverscape – otters, fishermen, disturbances – rather than spread the effort thin over an entire river basin. To work more closely with fishermen, particularly trying to understand the drivers of a decline in fish catch as reported by them, and to understand the impact otters might have on riverine fisheries, while at the same time quantifying loss to otters, if any.

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ANNEXURES

Data sheets and financial report have been submitted as attachments along with this report.