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Species of conservation significance within and vicinity of Narayan Sarovar Sanctuary: Biodiversity and distribution

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ABSTRACT : "Biomap" of any protected area is essential for conservation and management of important species. However it is also widely accepted that the landscape matrix surrounding protected areas also plays an important role in protecting many species. Totally 54 transects were sampled in and vicinity of Narayan Sarovar Sanctuary (NSS) protected area to understand the distribution and status of "Species of Conservation Significance (SCS)". Among 40 SCS from NSS, 14 were plants, five reptiles, 14 birds and seven species were mammals. Distributions of some species were recorded from both, sanctuary and adjacent areas while some species were restricted up to only sanctuary or only adjacent areas. A distributional status of various SCS in and around NSS is given and existing threats associated with these species are also mentioned. The present study revealed presence of SCS outside the existing sanctuary and suggests expansion of sanctuary boundaries for conservation of SCS of NSS.

Keywords : Conservation, biodiversity, distribution, flora, fauna, Narayan Sarovar Sanctuary

INTRODUCTION

The potential objective in designating a natural protected area is to maintain the biological diversity in an ecosystem (Al-Saqer, 2003) and to conserve elements of biodiversity that are unable to survive elsewhere (Brandon, 1997; Bruner *et al*., 2001). Additionally, acquisition of baseline data on the distribution and status of ecobiologically important species is essential for their conservation. In this context, species inventories or "Biomap" of any protected area is essential for conservation, resource management (Oliver and Beattie, 1993) and improvement of the existing species status. However, it is widely accepted that the landscape matrix surrounding protected areas also plays an important role in protecting many species (Halpin, 1997; Hannah *et al*., 2002). Reserves

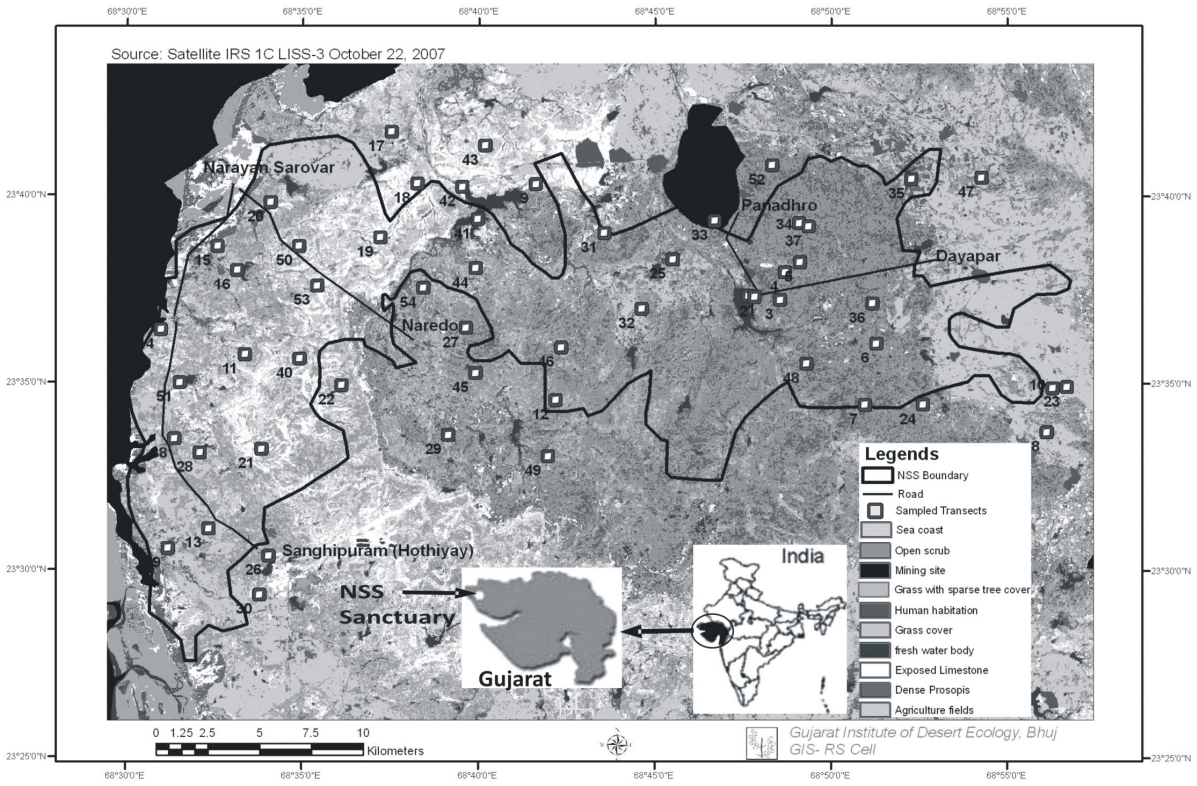

Fig. 1. Locations of transects laid within and vicinity of a Narayan Sarovar sanctuary (NSS)

alone will not be able to maintain landscape level biodiversity or resulting ecosystem services if they are isolated from the surrounding matrix (Gaston *et al*., 2002; DeFries *et al*., 2005). Successful conservation management requires an understanding of species distributions (Roy, 2003); including which species are restricted to protected areas and which are adequately protected outside these areas. In addition, owing to habitat fragmentation and consequent losses suffered by different populations, there is need for ensuring the safety of the threatened biodiversity lying outside the protected areas.

A study area, Narayan Sarovar Sanctuary (NSS) is located in the westernmost part of the Country (India), lies between 23°27' – 23°42' N latitude and 68°30' – 68°57' E longitude. NSS represents the ecological peculiarities of Biotic Province - 3A Kachchh, of Biogeographic Zone - the Indian Desert (Champion and Seth, 1968). Administratively, a NSS is located within the Lakhpat taluka of Kachchh district in state of Gujarat, India (Fig. 1). Large portion of the area of the sanctuary exhibits the edaphic climax of tropical thorn forest with tree height averaging 3 to 5 m. Major part of the sanctuary is under grassland and scrub forest, however, categorized in nine major habitat types *i.e*. 5/D-Dry deciduous Scrub, 6/E4 -Salvadora scrub, 6B/C-Desert Thorn Forest, 5/E3 -Babul (*Acacia nilotica*) forest, 6B/DS2-Tropical *Euphorbia* scrub, 5/DS5-Dry Savannah type vegetation, *Acacia nilotica*- Salvadora association, 6/E2-Gorad (Acacia Senegal), 6B/ DS1-*Zizyphus* scrub and *Capparis* association (Singh, 2001).

In Kachchh desert, a protected area - NSS provides natural habitat for numerous threatened species of plants, reptiles, birds and mammals (GUIDE & GEER, 2001; Sing, 2001). Furthermore, it having appropriate micro-climates and habitats, these varied types of habitats are available for breeding, feeding and other biological functions for various loral and faunal species. But presently all the natural habitats are under pressure of industrial and associated developments taking place at surroundings of NSS.

The present article fulfilled the research gaps in form of the preliminary and comprehensive information on current diversity and distribution of SCS floral and faunal (birds, reptiles and mammals) groups found in and vicinity of the NSS and also mentions existing threats to these important biodiversity of the sanctuary which may serve as a base line database for the conservation of NSS in future. This work was largely performed during the year of 2008.

MATERIAL AND METHODS

Present study was conducted on different periods of the year 2008. A total 54 sampling sites were randomly selected with in and vicinity of the NSS. The selection was broadly based on the habitat heterogeneity of the area. Sampling was carried out in selected sites to record floral and faunal diversity. Both, plants and animals were recorded in the belt transect of 1 km length crossing more than one habitat. For plants, width of the belt transect was 10-15 m. and threatened plant species present in the transect width were identified and documented (Mueller-Dombois and Ellenberg, 1967). Reptiles were recorded by Intensive search (IS) method conducted within a 6m width of the entire belt transect (Welsh, 1987; Welsh and Lind, 1991). All the micro habitats (rock and boulders, dead and fallen logs, flushing and beating of dense bushes and grass patches, checking of rock and tree crevices and leaf litters etc.) within the belt transects were thoroughly checked for presence of herpetofauna. Birds were recorded in the transect of variable width (Manuwal and Carey, 1991) according to the visibility and openness of the habitat. In addition, major water bodies in the study area were also surveyed for the aquatic bird species. Mammals were recorded by line transect method (Burnham et al., 1980) and also with the help of indirect evidences such as tracks/pugmark (Thommpson *et al*., 1989; Allen *et al*., 1996; Mohon *et al*., 1998; Edwards *et al*., 2000) and scat counts (Henke and Knowlton, 1995). Road kills for reptiles and mammals found on major roads passes through the sanctuary were also recorded. In addition, general visual observations and interviews of local peoples (residing inside the sanctuary) were also made to record possible threats to important wildlife species in NSS.

Plant and animal species mentioned as "SCS" are evaluated by using a criteria of WCMC (1994) for plants, IUCN for reptiles (Molur and Walker, 1998) and mammals (Molur *et al*., 1998), and Bird Life International (2001) for birds.

RESULTS AND DISCUSSION

Totally 54 transects were laid in and around the NSS to record important floral and faunal species. Out of total transect sampled, 35 were laid inside the NSS boundary and 19 were laid in vicinity (adjacent area) of NSS. During present study, overall 40 SCS plants and animal were recorded from various transect locations. Among total SCS recorded from NSS, 14 were plants, 5 reptiles, 14 birds and 7 were mammals.

Present study confirms the presence of 14 SCS plants mentioned in the various categories of WCMC, 1994 which includes one species of tree, two shrubs, seven herbs and three of climbers (Table 1). Out of total 14 plant species, 12 were recorded from NSS as well as adjacent habitats of the sanctuary while remaining two *i.e. Indigofera caerulea* and *Corallocarpus conocarpus* were recorded only from sanctuary. Among all SCS plants, *C. conocarpus*, *Dactyliandra welwitschii* and *Limonium stocksii* are highly threatened (Joshua, *et al*., 2006), among these *D. welwitschii* was recorded from 9 transects from NSS as well as from seven transects located in its vicinity; and *L. stocksii* was recorded from five transects of NSS and one transect located in adjacent habitat. Maximum six numbers of SCS plants were recorded from transect number 19 located inside the sanctuary, however at least one SCS plant was recorded from each transect laid inside as well as outside of NSS which proves conservation significance of sanctuary and

its surrounding habitats for conservation of these plants. GUIDE & GEER (2001) and Singh (2001) have mentioned that, a sanctuary supports 11 threatened plant species as

Table 1 : Occurrence of SCS plant species in various transects laid within and vicinity of NCC.

S.No.	Group	Species	WCMC 1994	Transect numbers of species occurrence
1.	tree	*Commiphora wightii*	I and	1, 2, 3, 4, 5, 6, 7, 9*, 10*, 12, 15, 16, 18*, 19, 20, 21, 22*, 23*, 24*, 26*, 27*, 28, 30*, 31, 33, 36, 37, 38, 39, 40, 41, 43*, 44, 46, 48, 50, 53, 54*
2.	shrub	*Campylanthus ramosissimus*	R	10*, 24*,31, 44, 48
3.		*Ephedra foliata*	VU	8*, 10*, 11, 19, 24*, 25, 29, 31, 32, 34, 42, 44, 45*, 47*, 48, 49*, 51
4.	herbs	*Helicrysum cutchicum*	R	1, 2, 3, 4, 5, 7, 9*, 12, 15, 16, 20, 22*, 23*, 26, 28, 30*, 33, 36, 37, 38, 39, 41, 43*, 48, 50, 53, 54*
5.		*Heliotropium bacciferum*	I	8*, 11, 13, 14, 17*, 19*, 25, 29, 32, 34, 35, 36, 45*, 47*
6.		*Heliotropium rariflorum*	I	8*, 11, 13, 14, 17*, 19*, 25, 29, 47*, 32, 34, 35, 42, 45*, 49*, 51, 52*
7.		*Indigofera caerulea*	R	19
8.		*Limonium stocksii*	I	11, 19, 21, 40, 43*, 53
9.		*Sida tiagii*	I	6,21, 23*, 26, 40
10.		*Tribulus rajasthanensis*	I	5, 7, 10*, 20, 22*, 24*, 28, 31, 39, 41, 44, 48
11.		*Convolvulus stocksii*	I	6, 7, 21, 27, 40
12.	climber	*Citrullus colocynthis*	R	8*, 11, 13, 14, 17*, 19*, 21, 25, 27*, 29, 32, 34, 35, 40, 45*, 47*, 49*, 51, 52*
13.		Corallocarpus conocarpus	CR	32
14.		Dactyliandra welwitschii	VU	3, 5, 9*, 10*, 20, 23*, 24*, 26*, 30*, 31, 39, 43*, 44, 46, 48, 50

* Transects located in vicinity (outside) NSS, R- Rare, VU- Vulnerable, CR- Critically Endangered, DD- Data Deficient, I- Indeterminenent

mentioned in Red Data Book of Indian Plants *viz. Campylanthus ramosissimus, Citrullus colocynthis, Commiphora wightii, Dipcadi erythraeum, Helicrysum cutchicum, Heliotropium bacciferum, H. rariflorum, Ipomoea kotshyana, I. caerulea, Tribulus rajasthanensis, Ephedra foliata.*

Among vertebrates, only five species of reptiles mentioned in various categories of IUCN (Molur and Walker, 1998) (Table 2) were recorded from 16 transects, of these 16 transects, six transects were located out side NSS. Maximum two species of reptiles were recorded from transect number 53 located in the sanctuary. Out of five species of reptiles, three were found only from sanctuary while *V. bengalensis* was reported only from transect located outside the sanctuary however road kills of this species was also reported from the sanctuary. *S. hardwickii* was abundantly distributed inside as well as adjacent habitats of the sanctuary. An endemic gecko, *Cytrodactylus kachhensis* of this region was reported from two transects numbers *i.e.* 37 & 53 located inside the NSS (Table 2). Being an endemic, no detailed information is available on its distribution in the study area (Joshua *et al.*, 2006) so these two records contribute very important information on the distribution of *C. kachhensis.*

Seven species of mammals enlisted in various categories of IUCN (Molur and Walker, 1998; Molur *et al.*, 1998) (Table 2) were recorded from 28 different transects (Table 2). Among these 28 transects, three were located outside NSS. Though the mammals were recorded from only three transects located outside the sanctuary, these transects had richness of six species out of seven (except *Viverricula indica*). Indirect evidences (scats and tracks) of *Hyaena hyaena* and *Vulpus bengalensis* were recorded from maximum of transects locations *i.e.* 27 and 26 transects respectively (Table 2). A reare species, *Panthera pardus* was sighted from single transect number 24, located in vicinity of the NSS. GUIDE and GEER (2001) recorded many species of mammals *i.e. H. hyaena, Caracal caracal, Felis silvestris, Canis lupus, Gazella bennettii, Mellivora capensis* and *P. pardus* from NSS. Maximum three species of mammals were recorded from 26 different transects located inside as well as adjacent to NSS.

Overall 14 species of birds enlisted in the various categories of the International Bird Life (2001) (Table 2) were recorded from 27 transects, of which nine transects were located outside the NSS. Though, maximum seven species were recorded from transect number one located in the sanctuary, two species, *Butastur teesa* and *Saxicola macrorhyncha* were reported only from transects located outside the NSS i.e. transect number 8 and 43 respectively.

Furthermore, of the total 14 species, 12 were recorded in the sanctuary as well its adjacent habitats. This instance proves the potentiality of adjacent habitats of the sanctuary for vulnerable avifauna. Similarly, some species *i.e. Falco naumanni, Pseudibis papillosa, Haliaeetus leucogaster, Phoenicopterus minor* and *Parus nuchalis* were recorded only from sanctuary, which again shows importance of protected area for conservation of the important bird species. Singh (2001) has mentioned that, sanctuary provides habitats for threatened birds like, *Ardeotis nigriceps* (Great Indian Bustard), *Chlamydotis undulate* (Houbara Bustard), *Sypheopides indica* (Lesser Florican), *Parus nuchalis, Pelecenus crispus* (Dalmaian pelican), *Aythya nyroca* (Ferruginous poachard) and *Aquila heliaca* (Imperial eagle).

Table 2 : Occurrence of SCS vertebrates (reptiles, birds and mammals) in various transects laid within and vicinity of NSS.

S.No.	Species scientific name	Common		
name	IUCN status	Transect numbers of specie occurrence		
Reptiles				
14	*Cytrodactylus kacchensis*	Banded Rock Gecko	DD	37, 53
15	*Sara hardwickii*	Spiny-Tailed Lizard	VU	7, 8*, 9*, 11, 14, 26*, 27*, 38, 42*, 50, 53
16	*Varanus bengalensis*	Common Indian Monitor	VU	27*
17	*Coelognathus helena*	Common Indian Trinklet Snake	LR-nt	3
18	*Echis carinatus*	Indian Saw-Scaled Viper	LR-nt	4,6
Birds				
19	*Butastur teesa*	White-eyed Buzzard	VU	8*
20	*Gyps indicus*	Long-billed Vulture	CR	1, 42*
21	*Gyps bengalensis*	Indian White-backed Vulture	CR	1, 41, 42*, 52*
22	*Circus macrourus*	Pallid Harrier	NT	1, 3, 10*, 24*, 48, 51
23	*Falco tinnunculus*	Common Kestral	VU	1, 24*, 29*
24	*Falco naumanni*	Lesser Kestral	NT	6, 14, 16
25	*Threskiornis melanocephalus*	Black-headed Ibis	NT	1, 16, 35, 36, 39, 46, 54*
26	*Pseudibis papillosa*	Black Ibis	NT	1, 35, 36, 38
27	*Mycteria leucocephala*	Painted Stork	NT	1, 4, 16, 35, 54*
28	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	CR	4, 19, 50
29	*Hieraaetus pennatus*	Booted Eagle	VU	10, 14, 18*
30	*Phoenicopterus minor*	Lesser Flamingo	NT	16
31	*Saxicola macrorhyncha*	Stoliczka's Bush chat	VU	43*
32	*Parus nuchalis*	Pied Tit	VU	7, 14, 32, 51
Mammals				
33	*Canis lupus*	Indian Wolf	LR-nt	13, 15, 19, 21, 25, 41, 53, 54*
34	*Vulpes bengalensis*	Indian Fox	LR	1, 2, 4, 13, 14, 15, 16, 19, 21, 24*, 28, 31,32, 34, 35, 36, 37, 38, 39, 40, 41, 44, 46, 48, 50, 52*
35	*Hyaena hyaena*	Striped Hyena	LR-nt	1, 3, 4, 5, 13, 14, 16, 19, 20, 21, 25, 28, 32, 34, 35, 37, 38, 39, 41, 44, 46, 48, 50, 51,52*, 53, 54*
36	*Panthera pardus*	Common Leopard	VU	24*
37	*Felis silvestris*	Desert Cat	LR-nt	1, 3, 4, 5, 7, 11, 41, 44, 46, 48, 50, 51, 52*, 53, 54*
38	F*elis chaus*	Jungle Cat	LR-nt	1, 3, 4, 7, 5, 11, 31, 32, 34, 35, 36, 37, 41,44, 46, 48, 50, 52*, 53, 54*
39	*Viverricula indica*	Small Indian Civet	LR-nt	13, 19

* Transects located in vicinity (outside) NSS, R- Rare, VU- Vulnerable, CR- Critically Endangered, LR-nt- Lower Risk near threatened,

NT- Near Threatened, DD- Data Deficit

Result of the study clearly indicates the ecological importance of habitats of NSS for survival of many SCS plants and animals. Furthermore the present study also proves potentiality of the adjacent habitats of the NSS which also supports to the many SCS taxa. In 2001, Singh already mentioned that, NSS provides habitats for 15 threatened species of wildlife belonging to Schedule-I of the wildlife (protection) Act, 1972 and thus representing a distinct gene pool of Indian arid region. Apart from presently recorded plant and animal species, many other species belonging to threatened category of IUCN or enlisted in various schedule categories of Indian Wildlife Protection Act (IWPA 1972-91) have been enlisted by GEER and GUIDE (2001).

The recent study revealed that, some SCS are present in and adjacent habitats of the sanctuary while some are restricted up to the sanctuary. However, it is also evident that some important species are surviving outside the existing boundaries of the sanctuary and are more prone to threat which needs urgent conservation by expansion of the existing boundaries of the NSS.

Threats to SCS in NSS. Unregulated animal husbandry activities and spread of invasive alien species:

The grasslands patched of the sanctuary area are overgrazed by cattle and buffalo allowed to roam freely. Several grasslands have been eroded due to overgrazing. These animals have also facilitated the spread of invasive alien plant, Mesquite (*Prosopis juliflora*), since they feed on the pods of the plant. *P. juliflora* have invaded the many terrestrial and aquatic ecosystems of the gradually displacing native scrubland plant species, leading to monoculture stands.

Hunting and poaching of animals. Collection and poaching of *Sara hardwickii* occur regularly in the NSS by some nomadic tribes (Joshua et al., 2006) mainly for oil extraction and for food (meat) and also due to some superstitious thoughts.

Road Kills. Road kills of the species like, *Hyena hyena*; *Felis chaus*; *Varanus bengalensis, S. hardwakii; Varanus bangalensis* and *Echis carinatus* were documented from a road connects Dayapar and Panandhro village passes through the NSS.

Awareness programme should be conducted among local people to conserve the biodiversity it can help to minimize hunting and poaching of animals. Road kills of the animals can be controlled by putting signboards of speed limits in the sanctuary. Unregulated animal husbandry activities are responsible for spreading of seed of invasive alien species (*P. juliflora*) through the excretory material during activity inside the sanctuary, so forest department should formulate strict strategy against uncontrolled grazing. The present study not only provide general information about the distribution status of important plants and animals species in NSS, but also reveals occurrence of these ecologically important species in surrounding areas of the NSS which need to declare as a part of sanctuary would be apparently contribute to the conservation of biodiversity of the NSS.

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