REMOTE SENSING BASED HABITAT AVAILABILITY MODEL (HAM) - A TOOL FOR QUICK-LOOK ASSESSMENT OF WETLANDS AS WATERBIRD HABITATS

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Introduction

Wetlands are defined by the Ramsar Convention, 1971 as the areas of marsh, fens, peatland or water whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.

Wetlands perform a wide range of functions that are essential for supporting a variety of plant and animals life. One of their important functions is of providing habitat to waterbirds. However due to various activities of man like unchecked vegetation removal, channellisation, filling, draining, dredging, construction of barrages and encroachment of the peripheral areas of the waterbodies wetlands are facing destruction and degradation, which further leads to the progressive loss of biological diversity including diversity of waterbirds (Maltby, 1986; Hussain and Roy, 1993; Brij Gopal and Krishnamurthy, 1993). Under such situation, there is an urgent need of monitoring and sustainably managing at least protected wetland areas on priority basis by applying modern tools and techniques.

Satellite remote sensing is a technique which is found very useful for this purpose. This is because, it provides synoptic and repetitive coverage of a wetland through multi-spectral nature of data Tatu *et al.* (1998) have demonstrated a methodology for remote sensing of waterbird habitats in an inland wetland which is based on habitat distribution mapping. However, apart from mapping and monitoring waterbird habitats in wetlands, satellite remote sensing can also facilitate evaluation of wetland as wildlife (waterbird) habitat by development of the quantitative models. Wildlife habitat evaluation by developing remote sensing based quantitative models has been carried out by Roller (1978), Roller and Colwell (1978) and Pettinger *et al.* (1978). Attempts for developing such models specifically for waterfowl are, however, scarce. An important example of such an attempt is that of Roller and Colwell (1978). They developed a computer based model to evaluate waterfowl habitat quality rapidly and objectively by assigning a numerical habitat quality rating.

However, it has been felt that there is a need of developing such a model which quickly provides a quantitative insight into availability of different habitats/micro-habitats required by a waterfowl species at a wetland prior to the detailed evaluation of the habitat quality. Habitat Availability

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Model (HAM) described in the present paper is one such model. Using a grid-based quantitative approach, it rapidly evaluates the magnitude of habitat availability with respect to all types of the habitat required by important waterbird species occurring in a wetland. It may enable the field based wildlife/wetland managers of developing countries to construct and apply appropriate models on the similar lines for managing wetland as habitat for important waterfowl.

Habitat Availability Model (HAM) - A quantitative approach for assessing habitat availability : It is essential for the management of a wetland as waterbird habitat to have information regarding the existing diversity of available habitats required by a waterbird species. Such knowledge, if available simply in a subjective (descriptive) or qualitative mode may hinder in having a comprehensive understanding about the number of habitats available for a waterfowl in different segments of the wetland. In turn, the ease of applicability of such information is also less in managing different parts of the wetland from year to year. This is due to the fact that wetland ecosystem being dynamic in nature, the habitat availability in different unit areas may keep on changing temporally. A quantitative, model-based approach on the other hand may help a wetland/wildlife manager in objectively and hence quickly understanding the existing status of habitat availability parameters. Such parameters are : (i) magnitude of habitat availability (zero, minimum, low, moderate, high, maximum), and (ii) spatial distribution of available habitats in the wetland with reference to geographical co-ordinates or some other known geographical features. Magnitude of habitat availability can be determined from the number of habitats available for a waterbird in unit area/segment of the wetland with respect to the total number of habitats required by the waterbird.

HAM is one such model which facilitates division of the entire wetland into the grid consisting of cells, each of 1 x 1 km^2 size and then knowing the magnitude of habitat availability for a waterbird in each cell. By comparing the number of cells with zero, minimum, moderate or maximum habitat availability for one year with such number for another year, a trend of habitat availability for a waterfowl can also be monitored. Such monitoring can further be helpful for habitat management practices. As the grid is made with reference to the geographical co-ordinates (latitude/ longitude) or other important geographical features of the area, the exact spatial location of each cell and thus the available habitats therein for a waterfowl can also be know. Both these factors, i.e. objective information on number of habitats available for a waterbird in a cell and location of the cell having varied habitat availability can help wildlife/wetland managers to have a quick insight in to the status of habitat availability for a waterbird to be conserved during any one year.

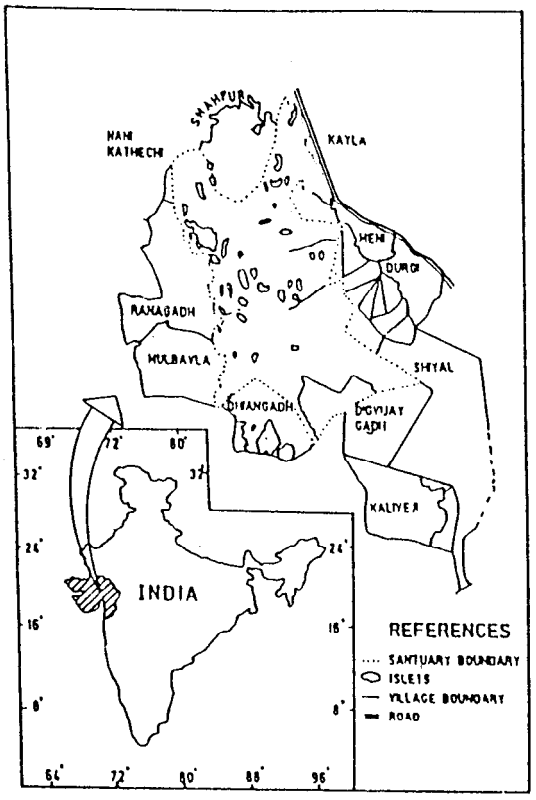
In the present paper, the development and application of the HAM has been demonstrated for two waterfowl species occurring at a wetland - Nal Sarovar (Gujarat State, Western India). The model is developed for different years (pre-drought, drought and post-drought) having different weather conditions. Its application for the *in-situ* habitat management is demonstrated for the model developed for one year. The two species are White Pelican (*Pelecanus onocrotalus*) and Chestnut Bittern (*Ixobrychus cinnamomeus*). The

Pelican has been recorded to be one of the most abundant and conspicuous waterfowl species utilising open waters and their edges at Nal Sarovar whereas the Chestnut Bittern is one of the rarest and secretive waterfowl species utilising emergent aquatic vegetation.

Study Area

Nal Sarovar is located in Gujarat State between 22°40'N - 22°55'N and 71°92' E - 72° 08' E. It falls in two districts of the State, viz. Surendranagar and Ahmedabad (Fig. 1). The basin of this natural freshwater lake is elongated and undulating saucer type having very gentle slope running from East to North-West and North-West to South. The depth of water in the lake seldom exceeds 3 m and the water, especially in shallow portions, becomes brackish to saline during summer. The lake is unique in the State by virtue of thick growth of emergent and submerged hydrophytic vegetation. The environs of the wetland is mainly constituted of cropland, fallow land and wasteland where the tree cover is dominated by *Prosopis juliflora* (Acharya, 1965; Wolstencraft *et al.*, 1989; Johri *et al.*, 1990; Hussain and Roy, 1993). It is located in the semi-arid saline tract, where the temperature is at peak during the months of April and May. The mean annual rainfall has been found to be 584.2 mm. The rainfall in the region is generally erratic. Thus, during the study period, the area received normal rains in 1984-85 but it experienced drought from 1985-86 to 1987-88 on one hand and received excess rains during 1988-89 and 1990-91 (Fig. 2).

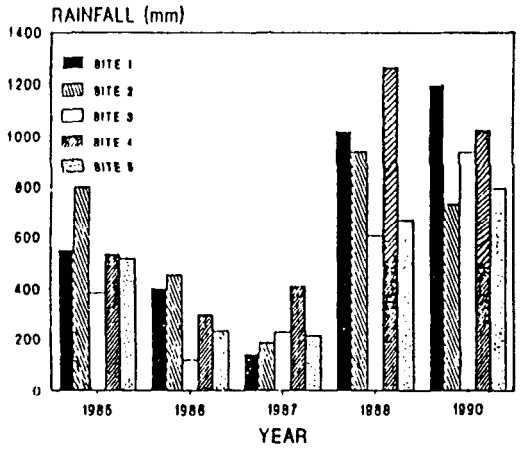
Fig. 1



Location of Nal Sarovar

The wetland is rich in avian wildlife. Hence about 120.82 km^2 area of this wetland is being protected as bird sanctuary by the State Forest Department since the year 1982. A variety of birds occupying aquatic and terrestrial niches occur at the wetland. A large number of migratory and resident waterfowl (waterbirds) congregate here in winter. About 113 waterbird species with the population of 2,24,245 were recorded during winter by the State Forest Department in the year 1992 (Anon., 1992). Its open water areas and shores often support large population of Pelicans, Spoonbill, Flamingoes, Ibises, Cranes, Ducks and Waders. On the other hand the reedbeds along the margins support marsh-dwelling secretive birds like Bitterns, Rallids and Snipes.

Fig. 2



Site 1 : Viramgam
Site 2 : Dhanuka
Site 3 : Senand
Site 4 : Dholka
Site 5 : Limbdi

Annual Rainfall (1985-90) at the sites around Nal Sarovar
(Source : Agricultural Statistics Deptt. Gujarat)

Presently the lake and its environs are under pressure due to activities of people viz., fishing, irrigation, cultivation, grazing, fodder harvesting, recreation based boating and tourism and thus there is the need of conserving waterbird habitats therein.

Material and Methods

Data used : Following remote sensing and collateral data were used for this study :

(i) Multi-temporal satellite data as listed in Table 1.
(ii) Survey of India (SOI) Topographical Maps at 1:50,000 scale.
(iii) Management plan of Nal Sarovar Bird Sanctuary from State Forest Deptt.
(iv) Waterfowl census data for the year 1991-92 from State Forest Deptt.

Table 1

Satellite data used for developing Habitat Availability Model (HAM) for Nal Sarovar as waterbird habitat

Satellite	Sensor	Date of acquisition	Remark
Landsat	MSS	24-1-1985	Pre-drought period
Landsat	TM	19-1-1987	Drought period
Landsat	TM	11-1-1990	Post-drought period

(v) Field data and literature regarding waterbirds.

Methodology : The flow-chart of the methodology adopted for the development of the Habitat Availability Model is shown in Fig. 3.

The development of the model is carried out in two stages :

(i) Habitat distribution mapping;
(ii) Habitat availability modelling.

Habitat Distribution Mapping

Major steps of habitat distribution mapping are described by Tatu *et al.* (1998). They are mentioned below :

- Demarcation of the wetland boundary for the preparation of the base map.
- Selection of the mapping scale.
- Visual analysis of satellite data to prepare preliminary Habitat Distribution Maps.
- Ground truth and accuracy checks.
- Preparation of the final Habitat Distribution Maps.

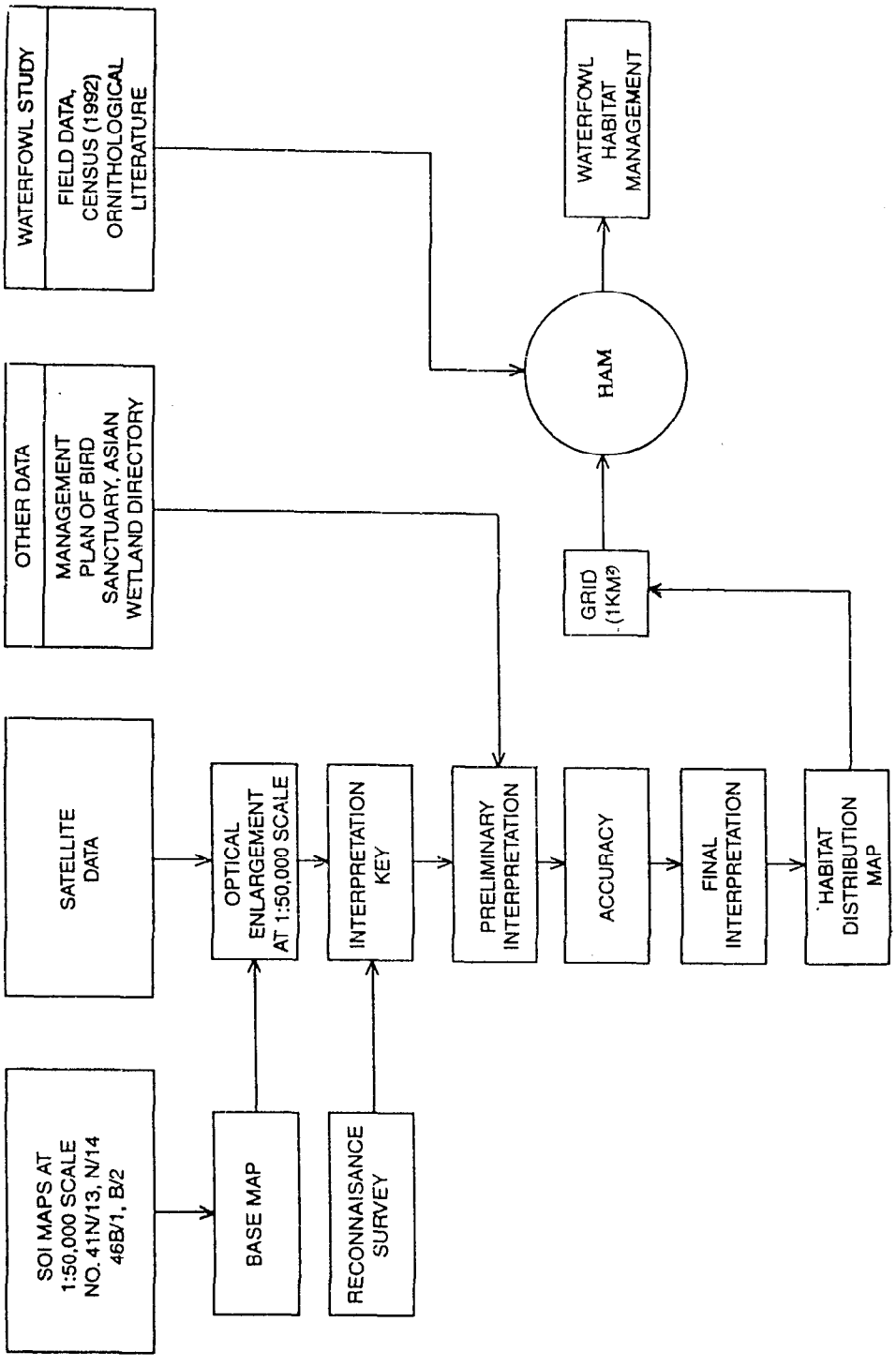
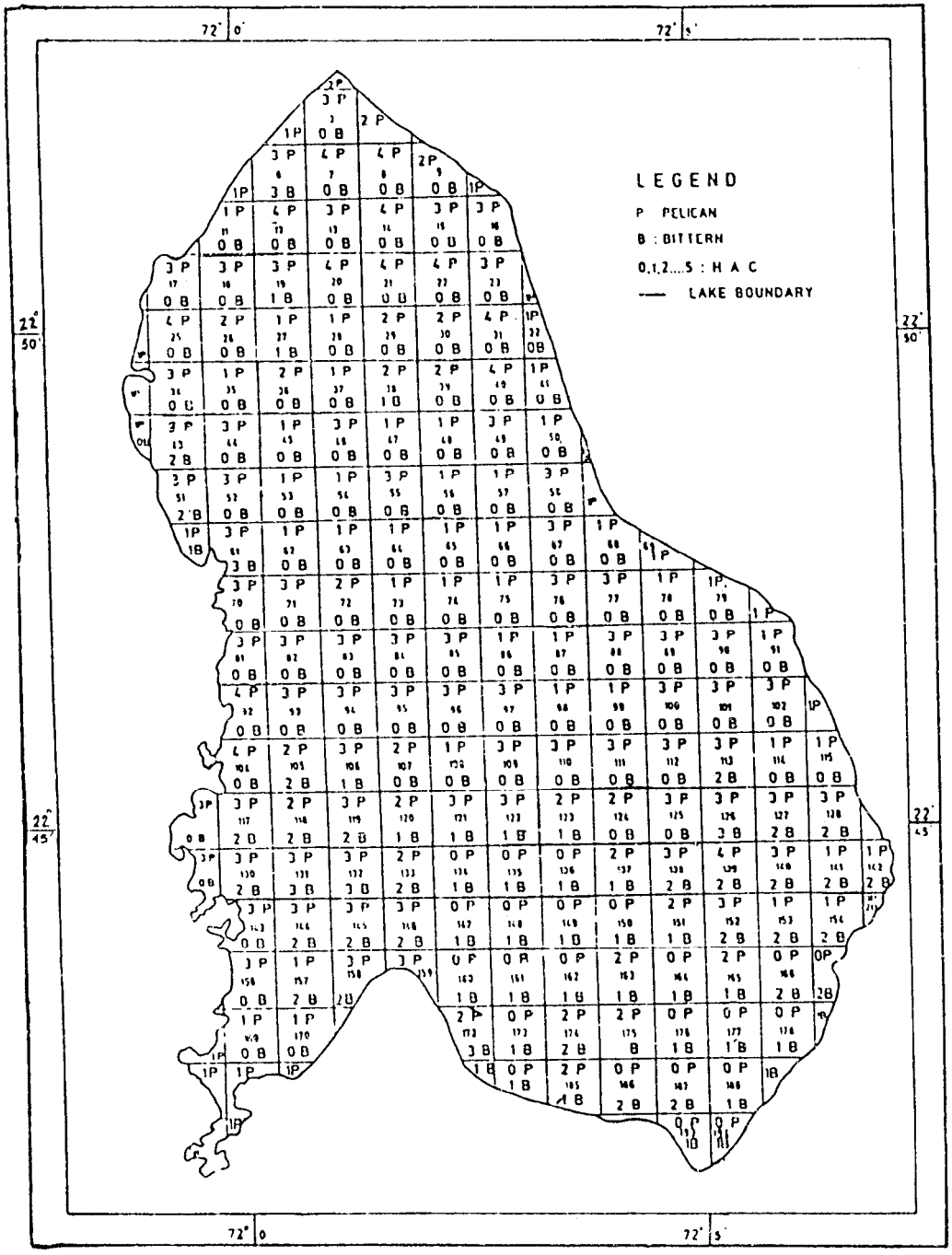


Fig. 3 Methodology flow chart for developing remote sensing based Habitat Availability Model (HAM)

Fig. 4



Habitat Availability Model, pre-drought period (January, 1985)

Note that HDMs have indicated spatial distribution of important waterfowl habitats during mid-winter season of three years viz. 1984-85 (Pre-drought year), 1986-87 (drought year) and 1989-90 (post-drought year). The habitats are : open water, emergent aquatic vegetation, islets (thickly vegetated and sparsely vegetated), and shore (with tree/shrub cover, with herbaceous cover, salt encrusted, waterlogged and barren). The maps have formed the basis for developing habitat availability models of pre-drought, drought and post-drought years as they have revealed the spatial distribution of the available habitats required by the White Pelican and Chestnut Bittern (Tatu *et al.*, 1998).

Habitat Availability Modelling

The step-by-step approach followed for the model development is given below :

Identifying Habitat Requirements : Habitat requirements of waterbirds for feeding, resting and roosting had been determined by conducting monthly field observations from August 1991 to May 1991. In addition, the standard ornithological literature had also been referred (Dharmakumarsinhji, 1955; Ali and Ripley, 1983).

The required habitats for White Pelican at Nal Sarovar have been found to be:

- Open water
- Sparsely vegetated or barren islets
- Barren land of the shore
- Edge between open water and sparsely vegetated/barren islet.
- Edge between open water and barren shore.

The required habitats for Chestnut Bittern are :

- Emergent aquatic vegetation
- Edge between emergent aquatic vegetation and shore
- Edge between emergent aquatic vegetation and sparsely vegetated/ barren islets.

Sampling Design : A grid at 1:50,000 scale was prepared by overlaying a tracing film on the base map. Each cell of this grid represents 1 km x 1 km sampling plot or unit area on the ground. Such plots are referred to as Main Sampling Plots (MSP). There are 136 such plots. The cells located on the boundary of the wetland have varying size (> 1 km^2) and shape. They are referred to as Marginal Sampling Plots (MRSP). There are 58 such plots. Thus total 194 plots in addition to some negligibly small plots on the boundary are spread over total 170 km^2 area of the wetland. The grid was overlaid on the Habitat Distribution Maps of the mid-winter season of pre-drought period of 1984-85 (January, 1985), drought period of 1986-87 (January, 1987) and post-drought period of 1989-90 (January, 1990).

The coding of the magnitude of habitat availability was done for each MSPs and MRSPs as follows :

(i) The magnitude of the habitat availability (in per cent) for the waterfowl in a unit area or sampling plot of the wetland was determined from the equation, HA=(100/N)*n. Note that 'N' represents total number of required habitats for the selected waterbed species at the wetland of Nal Sarovar and 'n' represents number of such habitats actually available for the species in each unit area sampling plot) of the

wetland. Also note that N=5 for Pelican and N=3 for the Bittern.

(ii) The magnitude of habitat availability has been assigned in the form of Habitat Availability Codes (HAC) from 0 (for 0% HA) to 5 (for 100% HA) for the White Pelican and 0 (0% HA) to 3 (100% HA) for the Chestnut Bittern.

Results and Discussion

Habitat Availability Model for the White Pelican and Chestnut Bittern for the pre-drought (1984-85) mid-winter period is shown in Figure 4. The magnitude of habitat availability in MSP and MRSPs during pre-drought, drought and post-drought years is given in Tables 2 and 3 respectively for the Pelican and the Bittern. Findings from the HAMs of the pre-drought, drought and post-drought period are discussed below.

Pre-drought period (January 1985) : The model has revealed following facts of the magnitude of habitat availability (Fig. 4) :

(i) In the MSP zone, 40 plots have potential of providing habitat of both the waterfowl species together. This makes 29 per cent of the total area of Nal Sarovar. They can be called Common Habitat Plots (CHP).

(ii) Total 78 MSPs constituting 45 per cent of the total wetland area have provided habitat to the Pelican. These plots can be called 'Species Specific Plots' for the Pelican or 'Pelican Habitat Plots (PHP)'.

(iii) Only 18 MSPs constituting 10 per cent of wetland area provide habitat to the Bittern. Number of such species specific plots for the Bittern (BHPs) are 44 per cent lower than those for the Pelican. The proportion of the CHPs in the MSPs is lower by 41 per cent than the proportion of the total species specific plots. This means that proportion of the plots which can provide habitat availability only to one of the two waterfowl species is higher than the plots providing habitat availability to both of them simultaneously. In other words, the habitat conditions in the MSP zone are such which can benefit more to the specialised habitat niches. In MRSP zone also, specialised rather than common habitat conditions prevail. In the MRSP zone, there are 20 CHPs whereas there are 32 and 9 PHPs and BHPs respectively.

(iv) For the Pelican, it has been found that the largest number of plots (viz. 55) have provided minimum, viz. 20% habitat availability (or one habitat) for resting, roosting or feeding. Total 42 MSPs provide moderate, viz. 60% habitat availability (or three habitats) for fulfilling various life requisites. However, very few plots (16) have made available all the five required habitats (100% habitats availability) for feeding, resting and roosting. Therefore, it can be said that the wetland mainly provides minimum to moderate habitat availability in the MSP for this species.

(v) For the Bittern, it has been found that the largest number of MSPs (85) have remained unavailable for carrying out any of the life functions. The number of MSPs providing minimum or 33% habitat availability (or one habitat) and moderate or 67% habitat availability (or two habitats) are 26 and 23, respectively. Negligible MSPs (2) provide all of the total four required habitats (or 100% HA) to carry out resting, roosting and feeding activities.

Drought period (January 1987) : The model

Table 2

Changes in Habitat Availability (HA) for the White Pelican during mid-winter seasons from pre to post-drought period in MSP and MRSP zones

HA Class (%)	Pre-drought period (Jan. 1985)		Drought period (Jan. 1987)		Post-drought period (Jan. 1990)	
	MSP (%)	MRSP (%)	MSP (%)	MRSP (%)	MSP (%)	MRSP (%)
Unavail. (0)	15 (11)	06 (10)	21 (16)	09 (15)	25 (18)	04 (6)
Min. (20)	55 (40)	47 (77)	109 (80)	52 (85)	72 (53)	54 (88)
Low (40)	02 (1.0)	01 (2.0)	006 (5)	0.0 (0.0)	04 (3)	01 (2)
Mod. (60)	42 (31)	05 (8)	0.0 (0.0)	0.0 (0.0)	28 (21)	01 (2)
High (80)	06 (4)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	02 (1.0)	0.0 (0.0)
Max. (100)	16 (9)	02 (3)	0.0 (0.0)	0.0 (0.0)	05 (4)	01 (2.0)

Table 3

Change in Habitat Availability (HA) for the Chestnut Bittern during mid-winter seasons from pre to post-drought period in MSP and MRSP zones

HA Class (%)	Pre-drought period (Jan. 1985)		Drought period (Jan. 1987)		Post-drought period (Jan. 1990)	
	MSP (%)	MRSP (%)	MSP (%)	MRSP (%)	MSP (%)	MRSP (%)
Unvail. (0)	85 (63)	45 (74)	83 (61)	39 (64)	44 (32)	38 (62)
Min. (33)	26 (19)	05 (8)	44 (32)	22 (36)	29 (21)	03 (5)
Mod. (67)	23 (17)	10 (16)	09 (7)	0.0 (0.0)	51 (38)	18 (30)
Max. (100)	02 (1)	01 (2)	0.0 (0.0)	0.0 (0.0)	12 (9)	02 (3)

has revealed following facts regarding magnitude of habitat availability :

(i) Due to severe effects of drought, the wetland has provided only one or two

habitats in MSPs for Pelican and Bittern, that too, only for resting/roosting. This is also true for MRSPs. Thus habitat availability conditions are deteriorated compared to 1984-85.

(ii) In all, 80 MSPs constituting 46 per cent of the wetland have provided resting/ roosting habitat for the Pelican, whereas 21 MSPs constituting 12 per cent of total wetland area provide habitat for the Bittern. On the contrary, total 35 MSPs are CHPs, constituting 20 per cent of the wetland area support resting/roosting life requisites of both the species.

It should be noted that due to absence of water in the wetland and dry condition of emergent vegetation, the habitat might have little value for both the waterfowl in the actual field conditions.

Post-drought period (January 1990) : The model has revealed following facts regarding magnitude of habitat availability:

(i) In the MSP zone there are 50 CHPs constituting 29 per cent of the total wetland area. Thus, compared to the drought period of 1986-87, the proportion of the unit areas of the wetland providing habitat availability to both the waterfowl together has been improved.

(ii) There are 45 PHPs constituting 26 per cent of the total wetland area. On the other hand, there are 41 BHPs constituting 23 per cent of the wetland area. Thus the number of unit areas (sample plots) of the wetland in MSP zone offering habitat availability only to the Pelican is nearly equal to those offering habitat availability only to the Bittern. This represents development of undesirable habitat conditions with respect to the Pelican and the Bittern, compared to such conditions during 1984-85. This is due to the fact that the proportion of the Bittern specific plots (41 in number) has increased at the cost of Pelican specific plots (45) over the years. Such increase is due to the spread of emergent aquatic vegetation, which can cause stress on habitat availability of the gregarious and abundant Pelican. Though the proportion of the Bittern specific plots has increased to nearly equal to that of Pelican specific plots (in MSPs), such increased proportion may be unnecessary looking to the rarity of the Bittern.

(iii) In the MRSP zone CHP are 33 per cent, BHPs are 14 per cent and the PHPs are 54 per cent of all the MRSPs. Thus in the MRSP zone wetland units offering habitat availability only to the Pelican is higher than those offering habitat availability only to the Bittern.

(iv) The proportion of CHPs (33 per cent) in MSP zone is much less than the proportion of total species specific plots (i.e. 64 per cent). It means that, similar to the pre-drought year, habitat conditions at Nal Sarovar in MSP zone during post-drought period have been such which can favour more to specialized niches.

(v) For the Pelican, it has been found that the largest number of MSPs (72) have provided minimum or 20% habitat availability (1 habitat) for resting/roosting or feeding activities. The number of MSPs not providing any habitat availability and those providing moderate or 60% habitat availability (3 habitats) are 25 and 28 respectively. Negligible number of MSPs (2-5) have provided high or 80% habitat availability (i.e. 4 habitats) to maximum or 100% habitat availability (5 habitats). Therefore it can be said that the wetland

has largely provided minimum to moderate habitat availability during the post-drought period.

(vi) For the Bittern, the largest number of plots (viz. 51) have provided moderate or 67% habitat availability (2 habitats) for feeding, resting and roosting activities. Moreover, there are 12 MSPs providing 100% habitat availability. It can be said that though considerable portion of the wetland falling in 44 MSPs has remained unavailable for the Bittern during post-drought mid-winter period, the magnitude of habitat availability for the Bittern was found to have improved during this period as compared to such status during pre-drought period as the large number (63) of MSPs has provided moderate to maximum habitat availability and moderate number of MSPs have provided minimum habitat availability.

Application of HAM for in situ management of wetland as waterfowl habitat : HAM has been developed in the present study by utilising satellite data of different weather conditions along with necessary field data. Owing to its grid based approach, it is found useful for identifying unit areas (sample plots) of the wetland having favourable to unfavourable conditions in terms of waterfowl habitat availability. The unit areas with favourable habitat availability can further be protected from adversely affecting anthropogenic and natural factors. The remaining areas with less favourable or unfavourable habitat availability for the important waterfowl can be used for socio-economic activities of man and can also be manipulated if required. However, as the wetland is dynamic ecosystem, the unit areas of with favourable habitat may change from year to year depending upon the weather conditions and thus there is a need of developing separate model from year to year. As the grid is made with reference to the geographical co-ordinates (latitude/ longitude), the exact spatial location of each of such unit areas and the available habitats therein for a waterfowl can be known rapidly. Though the model is developed for two representative waterfowl only, it can function as an effective tool in providing direction for planning of wetland management for a variety of waterfowl.

Here the application of HAM for habitat management is demonstrated with an example of HAM of the pre-drought year (January 1985).

Considering the CHPs providing moderate or higher habitat availability (60% / 67% or above) for both the waterfowl simultaneously as favourable unit areas for both the species, the sampling plots 6, 61, 113, 117, 119, 126-128, 130-132, 138-140, 144-146, 152 can be considered as favourable unit areas for both the waterfowl.

Considering the PHPs providing moderate (60%), high (80%) and maximum (100%) habitat availability to the Pelican as favourable unit areas with respect to the Pelican alone, the plots 3, 7, 8, 12-18, 20-23, 25, 31, 34, 40, 44, 46, 49, 52, 58, 67, 70, 71, 76, 77, 81-85, 88-90, 92-97, 100-102, 104, 109-112, 125, 156 can be considered as favourable unit areas for the species.

Similarly, considering that the BHPs providing moderate (67%) and maximum (100%) habitat availability to the Bittern as favourable unit areas with respect to the Bittern alone, the plots 165, 186 and 187 can be considered as favourable areas for the species.

From the view point of managing the wetland as habitat of the Pelican and the Bittern, all such unit areas having favourable habitat availability should be protected from adversely affecting anthropogenic and natural factors. The remaining sampling plots can be considered as unit areas with less favourable or unfavourable habitat availability for these waterfowl and can be used for socio-economic activities of man.

Conclusions

The grid-based Habitat Availability Model (HAM), has shown capability of quickly providing a quantitative insight into availability of different habitats/micro-habitats required by the White Pelican (*Pelecanus onocrotalus*) and Chestnut Bittern (*Ixobrychus cinnamomeus*) occurring at Nal Sarovar (Gujarat). It has been found that from pre-drought mid-winter season (January, 1985) to post-drought mid-winter season (January, 1990), total number of the MSPs (with 1 km x 1 km size) which can provide habitats to both the species together had remained lower than the proportion of the total number of plots which can provide habitat to any one of the two species. In other words, it can be concluded that the unit areas of the Wetland have provided, a rather specialised (or single species) habitat availability. It is also found that during mid-winter season of the pre-drought year, the status of the magnitude of habitat availability was much better for the White Pelican than that of the Chestnut Bittern. This is because, large number, i.e. 64 of the MSPs have provided moderate to maximum habitat availability to the Pelican. Contrarily, very large number (85) of MSPs had remained unavailable (i.e. zero habitat availability) for the Bittern and comparatively less number (35) of the plots provided moderate to maximum habitat availability to it. During drought period, the wetland had little value as habitat of the two waterfowl species owing to the absence of water and dry condition of the emergent vegetation. During post-drought mid-winter period, the magnitude of habitat availability for the Bittern was found to have improved as compared to such status during pre-drought period as the large number (51) of MSPs had provided moderate habitat availability and a good number (12) of MSPs had provided maximum habitat availability for the Bittern.

However, the number of PHPs had reduced during the post-drought year due to simultaneous increase in BHPs (this phenomenon has in fact occurred due to the spread of emergent aquatic vegetation). Looking to the abundance and gregarious character of the Pelican on one hand and rarity and solitary character of the Bittern on the other, increase in BHPs at the cost of reduction in PHPs represents development of undesirable habitat conditions at Nal Sarovar during post-drought mid-winter season with respect to the habitat management of these to species.

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SUMMARY

Due to various activities of man, wetlands are facing destruction and degradation which further leads to the progressive loss of biological diversity including diversity of waterbirds. Under such situation, there is an urgent need of monitoring and sustainably managing at least protected wetland areas on priority basis by applying modern tools and techniques. Satellite remote sensing is a technique which is found very useful for this purpose. Apart from mapping and monitoring waterbird habitats in wetlands, it can also facilitate evaluation of wetlands as wildlife (waterbird) habitats through the development of quantitative models. There is a need of developing such a model which quickly provides a quantitative insight into the availability of different habitats/micro-habitats required by a waterfowl species in the entire wetland prior to the detailed evaluation of the habitat quality/suitability. Habitat Availability Model (HAM) is one such model. With its grid-based quantitative approach, the model may help a wetland/ wildlife manager in quantitatively and quickly knowing the magnitude and spatial distribution of habitat availability for a waterbird at a wetland in 1 km x 1 km sampling plots spread over the entire wetland. In the present paper development and application of HAM has been demonstrated for two waterbird species occurring at Nal Sarovar (Gujarat) namely, White Pelican (*Pelecanus onocrotalus*) and Chestnut Bittern (*Ixobrychus cinnamomeus*). It may enable field based wildlife/wetland managers of developing countries to construct and apply appropriate models on the similar lines for managing wetlands as habitats for important waterfowl.

सुदूर संवेदन आधारित प्राकृतावास उपलभ्यता माडल – जलभूमियों में जलपक्षी प्राकृतावास का शीघ्र आकलन करने का उपकरण

केतान टाटू, एम०एम० किमोथी व जे०एस० परिहार

सारांश

मानवों के विविध क्रियाकलापों के कारण जलभूमियों को विनाश और व्याहास का सामना करना पड़ रहा है जिसके परिणमस्वरूप जैविकीय विविधता का भी धीरे-धीरे ह्रास होता जा रहा है जिसमें जलपक्षियों की विविधता भी सम्मिलित है । ऐसी स्थिति में कम से कम सुरक्षित जलभूमियों की पड़ताल आधुनिक उपकरण और प्रविधियां अपनाकर पूर्वता आधार पर करते रहने की तत्काल आवश्यकता है । उपग्रह द्वारा दूर संवेदन एक ऐसी प्रविधि है जो इस प्रयोजन के लिए बहुत उपयुक्त पाई गई है । जलभूमियों में जलपक्षी प्राकृतावासों का मानचित्रण और पड़ताल करने के अतिरिक्त यह वन्यप्राणियों (जल पक्षियों) के प्राकृतावास के लिए उनका मूल्यांकन अपनाकर मात्रात्मक प्रतिरूप (मॉडल) विकसित करके सुविधाप्रद बना देता है । ऐसे प्रतिरूप बनाने की आवश्यकता है जो किसी जलपक्षी जाति के लिए अपेक्षित विभिन्न प्राकृतावास/अणु प्राकृतावासों का समूची जलभूमि में विस्तार से मूल्यांकन कराने से पूर्व विभिन्न प्राकृतावासों/अणु प्राकृतावासों की उपलभ्यता मात्रात्मक दृष्टि शीघ्रता से उपलब्ध करा सके । प्राकृतावास उपलभ्यता प्रतिरूप (मॉडल) ऐसा ही प्रतिरूप है । सामान्य प्रकार की जाती पर आधारित मात्रात्मक अभिदृष्टि के कारण यह प्रतिरूप जलभूमि प्रबन्ध को समूची जलभूमि में वितरित । किमी X 1 किमी के न्यादर्शन क्षेत्रों की जलभूमि में जलपक्षियों के लिए प्राकृतावास उपलभ्यता को आकार और प्रसार में वितरण जानने का मात्रात्मक ज्ञान शीघ्र करा देता है । प्रस्तुत अभिपत्र में इसे प्राकृतावास उपलभ्यता प्रतिरूप (HAM) का विकास और उपयोज्यता नलसरोवर (गुजरात) में होने वाले दो जलपक्षियों अर्थात श्वेत प्लव (*पेलिकरनुस ओनोक्रोटालुस*) और चेस्टनट बिटर्न (*आइक्सोब्राइकस सिन्नामोमेउस*) को लेकर प्रदर्शित की गई है । यह विकासमान देशों के वन्यप्राणि जलभूमि प्रबन्धकों को इसी ढंग पर अपने यहाँ की जलभूमियों का महत्वपूर्ण जलपक्षियों के प्राकृतावासों के लिए प्रबन्ध करने में सहायक होगा ।

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