Available online at www.ijpab.com

International Journal of Pure & Applied Bioscience

ISSN: 2320 – 7051
Int. J. Pure App. Biosci. **3 (4):** 79-85 (2015)

INTERNATIONAL JOURNAL OF PURE & APPLIED BIOSCIENCE

Research Article

OPEN ACCESS

Monitoring of land use and land cover changes of Kapla beel, a major wetland of Barpeta district, Assam using multi temporal satellite data

Upen Deka*, Tapan Dutta and Pinaki kumar Rabha
Department of Botany J. N. College , Boko
*Corresponding Author E-mail: upen_deka@yahoo.in

ABSTRACT

Kapla beel is a perennial freshwater wetland of Barpeta district of Assam, India situated at the global position between $26^0 18' 12''$ N to $26^0 25' 7''$ N latitude and $91^0 08' 42''$ E to $91^0 14' 50''$ E longitude. The present investigation reveals that the wetland of the present study site has degraded or is under the stress of different environmental factors because of various natural as well as anthropogenic activities occurring over the last few decades. Land use and land cover change is a useful tool for determining the ecological degradation of wetland which is under the pressure of several natural as well as man-made activities. The present study has been carried out to delineate the changes of Kapla beel of Barpeta district, Assam using LANDSAT TM data. The results of the present study reveal that the water spread areas of Kapla beel is reduced by 50.3% and 45.5% in pre-monsoon and post monsoon season respectively during the year 1987 to 2013. It is mainly due to encroachment inside the wetland area for different developmental activities. Besides the construction of dykes surrounding the beel has caused formation of heavy detritus due to gradual death and decay of aquatic macrophytes inside the wetland areas which ultimately make the wetland very shallow. Therefore proper restoration measures of this important wetland of the district is the need of honor for the sustainable existence of the wetland and also livelihood of the poor people living in its vicinities.

Key words*: Kapla beel, anthropogenic activities, land use and land cover change, LANDSAT TM data and restoration measures.*

INTRODUCTION

Wetlands are the highly fragile ecosystem of the world. Wetland plays a significant role in regional ecosystem, such as the regulation of climate, cleansing of environment and balancing of regional water and provides suitable habitat for aquatic flora and fauna. Based on several estimates, the extent of the world's wetlands is generally thought to be from 7 to 9 million km^2, or about 4 to 6 percent of the land surface of the earth[17].

It has also been estimated that 20 % of the known range of biodiversity in India are supported by freshwater wetlands[4]. However in recent years, anthropogenic activities such as urban development and agricultural management have caused a significant change in the land use-land cover and subsequent loss of wetland [20].

Landscapes are not static, there are numerous exogenesic and endogenetic forces continuously operating over the landscapes and because of this landscapes are dynamic in nature. All over the world ecosystems have been rapidly transformed in the post-2000 period by human populations through increasingly permanent uses of land[8]. Land-use/land-cover (LULC) change is of much interest in environmental

analyses[1,9, 21]. Since land use change may contribute to ecological degradation[11] and is considered one of the most important variables of global ecological change[10, 19, 22].

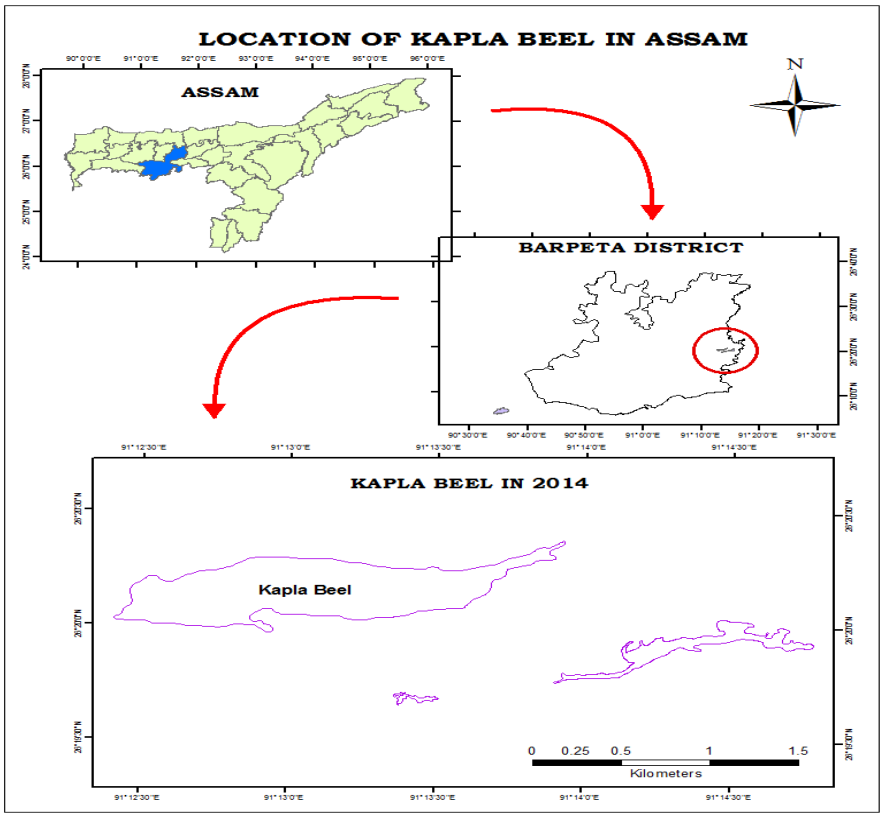
Remote sensing of wetlands using satellite data dates back to 1972 with the launch of Landsat-1 MSS. Around the world, regional level wetland mapping has been done by several workers using Landsat-1 Multispectral Scanner (MSS) imagery[23,2,13]. But due to the low resolution of Landsat MSS imagery, the thematic mapper (TM) multispectral instrument was launched on Landsat-5 in 1984, which brings increased spatial resolution (30 m) and increased spectral resolution (6 bands) to bear on the problem of wetland remote sensing. Landsat TM bands 4 (near infrared), 5 (mid-infrared), and 3 (red) were most optimal for discriminating between land-water interface[6,18]. Since then Landsat TM has been used for change detection of wetlands by several worker[5,15,3,12].

The study of critical review of literature reveals that the wetlands of North East India particularly in Assam are facing serious threats of degradation due to the increasing anthropogenic pressure. Therefore the present study has been carried out to investigate and evaluate the present status of Kapla beel of Barpeta district, Assam and to assess morphological change in the wetland ecosystem as well.

STUDY SITES:

The present investigation was carried out on Kapla beel of Barpeta district of western Assam. This wetland plays an important role for the improvement of socioeconomic condition of the poor people living in its surrounding areas. It covers an area of 91 hectares. The Beel is surrounded by five villages around its adjacent areas namely Haldhibari and Kaldipathar in east, Barkapla Gaon in west, Kamarpara Gaon in north and Salmara Gaon in the south. Kapla beel is a community managed beel which is mainly used for fishing through lease by the mahalder and thereby huge revenue have been collected from the beel annually. The beel has an inlet on the eastern side of the beel i.e. connected with Chilla beel and Hablakhowa beel and has an outlet on western side of the beel. The outlet of Kapla beel meet the river Brahmaputra on the southern side of the beel. Unfortunately, the outlet of Kapla beel gradually became narrow due to the luxuriant growth of invasive weed like *Eichhornia crassipes* and their gradual death and decay as well as encroachment in the nearby the outlet channel are responsible for the blockage of the outlet channel of the wetland.

Fig. 1: Location map of study site



MATERIALS AND METHODS

Data Source & Methodology for Land Cover Change Analysis

Data Source:

To analyze the land use change dynamics in Kapla beel of Assam multi dated, multi season satellite imageries were used. Besides this, the Survey of India topographical sheet at 1:50,000 scales were used for delineation the wetland boundary and to generate baseline information for the study area. The details of the datasets used in this study are shown in Table- 1

Table1: Datasets used for monitoring the LU/LC change of Kapla beel

Data Type	Path/ Row	Date of acquisition	
		Pre-Monsoon	Post-Monsoon
Landsat TM	136/42, 135/42	1987 (February & March)	1987 (September & October)
Landsat TM	136/42, 135/42	1999 (February & March)	1999 (September & October)
IRS LISS III	109/52, 111/52	2013 (February & March)	2013 (September & October)

Methodology

Satellite imagery of Landsat TM of 1987 and 1999 and IRS P6 LISS III of 2013 were used to analyze the land cover change dynamics of Kapla beel. The Landsat TM of 1987, 1999 and IRS P6 LISS Satellite image 2013 including the pre-monsoon and post-monsoon seasons were procured from National Remote Sensing Centre (NRSC), Hyderabad. The imageries were projected to UTM – WGS 84 projection system using Landsat ETM image as reference. Sub-pixel image to image registration accuracy was achieved through repeated attempt. Radiometric correction of all the images was done using dark pixel subtraction technique.[16] Buffer operation of the wetlands was done for two kilometer to assess the land use change in and around the wetlands. Re-sampling of IRS P6 LISS III imagery was carried out at 30 m. pixel size as the other imageries (Landsat TM 1987 and 1999) were of 30 m. resolution. Subset operation of satellite imageries of 1987, 1999 and 2013 was carried out by creating an area of interest (AOI) layer of the vector layers.

After sub setting, the images of the study area were processed through spectral enhancement technique using ERDAS imagine 9.2 software. Principal component analysis (PCA) was carried out to all the images. All the images were converted into three principal components. PCA is often used as a method of data compression. It allows redundant data to be compacted into fewer bands i.e. the dimensionality of the data is reduced. The bands of PCA data are non-correlated and independent, and are often more interpretable than the source data[14]. After generating the hybrid PCA images for all the years a supervised classification, technique was used using maximum likelihood algorithm to assess the land cover change dynamics in fringe areas of wetlands from 1987 to 2013. Since supervised classification is a process where the image analyst supervised the pixel categorization process by specifying to the computer algorithm, numerical descriptors of the various land cover types present in a scene[16]. Many researchers have been using supervised classification technique to extract the features from the remotely sensed imagery, as it demonstrates the classification that can incorporate both the spectral and spatial features of the pixels in the image resulting in better defined categories in terms of its homogeneity[7]. Based upon the ground data, classes were assigned in the PCA based images. Five land use types were identified from the field observation and training sets of the land cover classes were gathered using handheld GPS receiver. After classifying all the images of 1987, 1999 and 2013 the post classification comparison method was used to detect the changes in land cover types in Kapla beel. The method consist in overlaying, using a cross operation, the comparison of two images and classification. The cross operation allows the analyst to know the extent and nature of the changes observed, in other words, the transition between different land cover classes and the corresponding areas of change. Applying this method finally, land cover change analysis of Kapla beel of Assam has been done. The output resolution of all the classified images was at 30 m. All these image-processing operations were carried out in ERDAS Imagine 9.2 software.

RESULTS AND DISCUSSION

The land use and land cover change of the wetland in pre-monsoon and post-monsoon season during three consecutive years have been presented in Table 2.

It has been found that during the pre-monsoon season the total area of open water bodies of the wetland has decreased by 2.48 sq. km from 1987 to 2013 which represents 50.3% area lost during this period. It has been found that massive decline occurred between the periods 1999 to 2013 i.e., 1.39 sq. km whereas the decline between the periods 1987 to 1999 is found to be 1.09 sq. km only (Table 2). Similarly during the post-monsoon season also the total area of open water bodies of the wetland has decreased by 2.63 sq. km from 1987 to 2013 which represents 45.5% area lost during this period. Significantly it has been found that massive decline occurred between the periods 1987 to 1999 i.e., 1.75 sq. km where as the decline between the periods 1999 to 2013 is found to be 0.88 sq. km only (Table 2). This decrease of water spread areas of the wetland is mainly due to increased encroachment nearby the wetland areas by the local villagers for construction of houses as well as the construction of dykes surrounding the wetland.

Table 2: LU/LC changes of Kapla beel during the study period: Area in (km^2)

	1987		1999		2013	
Land use classes	**Pre Monsoon**	**Post Monsoon**	**Pre Monsoon**	**Post Monsoon**	**Pre Monsoon**	**Post Monsoon**
Woodland (Dense)	2.88	2.88	2.12	2.05	1.91	1.45
Woodland (Open)	3.42	3.46	3.1	3.2	2.89	2.91
Cropland (Rabi)	6.81	5.79	6.61	6.62	7.12	7.13
Cropland (Kharif)	8.23	9.42	9.96	10.32	10.89	11.56
Agriplantation	4.39	4.39	4.78	4.71	5.98	5.97
Water Body	4.93	5.78	3.84	4.03	2.45	3.15
Total	**30.66**	**30.66**	**30.66**	**30.66**	**30.66**	**30.66**

It has been found that during the pre-monsoon season the total area of woodland (dense and open) has been decreased by 0.97 sq. km and 0.53 sq. km respectively from 1987 to 2013. The massive loss has been occurred between the periods 1987 to 1999 which are found to be 0.76 sq. km and 0.32 sq. km respectively whereas the decreased found between the periods 1999 to 2013 is 0.21 sq. km each during the study period (Table 2). Similarly during the post-monsoon season also the total area of woodland (dense and open) has been decreased by 1.43 sq. km and 0.55 sq. km from 1987 to 2013. Between the periods 1987 to 1999, the decreased has been found to be 0.83 sq. km and 0.26 sq. km whereas the decreased between the periods 1999 to 2013 was found to be 0.6 sq. km and 0.29 sq. km respectively (Table 2).

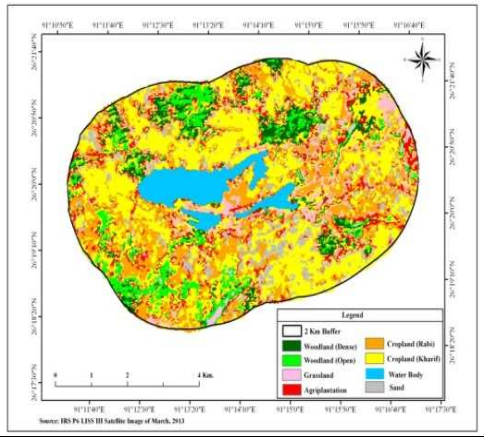
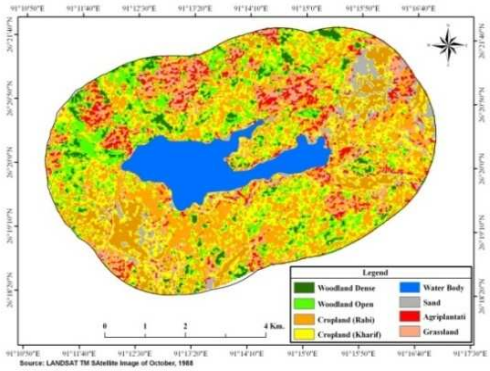
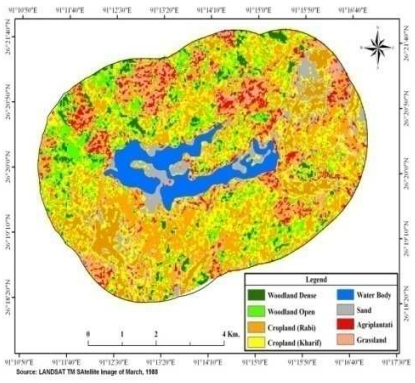
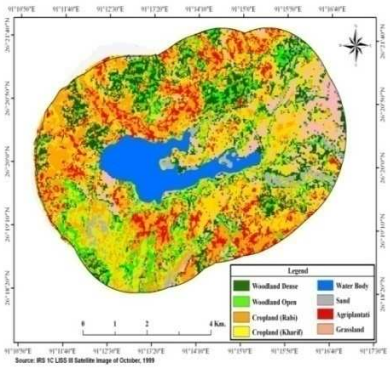
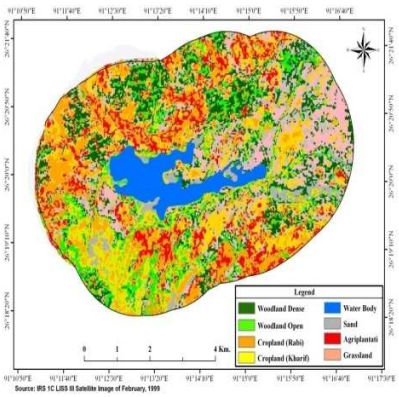
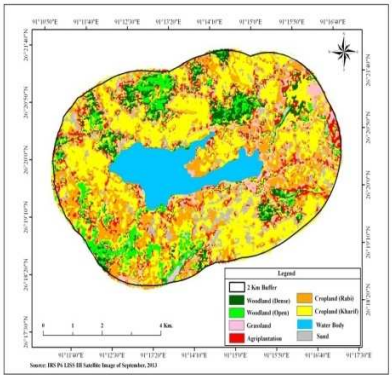
In the pre-monsoon season the total area of rabi cultivation has been increased by 0.31 sq. km from 1987 to 2013 which represents 4.5% area increased inside the wetland areas during this period. The massive increased of area of rabi cultivation has been occurred between the periods 1999 to 2013 i.e. 0.51 sq. km whereas the decreased between the periods 1987 to 1999 was found to be 0.20 sq. km (Table 2). Similarly during the post-monsoon season also the total area of rabi cultivation has been increased by 1.34 sq. km from 1987 to 2013 which represents 23.14% area increased inside the wetland areas during this period. Between the periods 1987 to 1999, the increased of rabi cultivation inside the wetland areas has been found to be 0.83 sq. km whereas the increased area between the period 1999 to 2013 was found to be 0.51 km^2 (Table 2).

During the pre-monsoon season the total area of kharif cultivation has been increased by 2.66 sq. km from 1987 to 2013 which represents 32.3% area increased inside the wetland areas during this period. The massive increased of area of kharif cultivation has been occurred between the period 1987 to 1999 i.e. 1.73 sq. km and the increased between the period 1999 to 2013 was found to be 0.93 sq. km only (Table 2). Similarly during the post-monsoon season also the total area of kharif cultivation has been increased by 2.14 sq. km from 1987 to 2013 which represents 22.7% area increased inside the wetland areas during this period. Between the period 1987 to 1999, the increased of kharif cultivation inside the wetland areas

has been found to be 0.90 sq. km whereas the increased between the period 1999 to 2013 was found to be 1.24 km^2 (Table 2).

Similarly during the pre-monsoon season the total area of agriplantation has been increased by 1.59 sq. km from 1987 to 2013 which represents 36.2% area increased inside the wetland areas during this period. The massive increased has been occurred between the period 1999 to 2013 i.e. 1.20 sq. km and the increased between the period 1987 to 1999 was found to be 0.39 sq. km (Table 2). Similarly during the post-monsoon season also the total area of agriplantation has been increased by 1.58 sq. km from 1987 to 2013 which represents 35.9% area increased inside the wetland areas during this period. Between the period 1987 to 1999, the increased of agriplantation inside the wetland areas was found to be 0.32 sq. km whereas the increased between the period 1999 to 2013 was 1.26 sq. km (Table 2).

Fig. 2: Changes of Land Use and Land Cover pattern of Kapla beel during Pre-monsoon and Post-monsoon seasons in three different years i.e. 1987, 1999 and 2013.

	Pre-monsoon	Post- monsoon
1987		
1999		
2013		

CONCLUSION

The results of the present study reveal that significant loss of areas has been occurred in the wetland of the present study site during the last two decades. It is mainly due to illegal encroachment inside the wetland areas for construction of houses by the local villagers, construction of dykes surrounding the beel leads to luxuriant growth of invasive exotic aquatic weed like *Eichhornia crassipes* and some other dominant aquatic macrophytes which after death and decay increased the peat formation in the wetland. This has resulted the shallow condition of the wetland. Simultaneously people began to cultivate in those shallow bed of the wetland for agricultural practices. This threads has resulted not only the shrinkage of the wetland areas but also affect the overall environment of the wetland ecosystem as well. In order to conserve this important wetland of the district from various ongoing natural as well as anthropogenic activities, following recommendation have been given- i) Illegal encroachment inside the wetland areas should be totally stopped, ii) Unscientific developmental activities in and around the wetland areas should be minimized, iii) Eradication of aquatic invasive exotic weed i.e. *Eichhornia crassipes* from the wetland.

Acknowledgement

Authors are gratefully acknowledged to the University Grants Commission (UGC) Govt. of India for providing the financial assistance under Major Research Projects [Project No: F. No. 42 971/2013 (SR) - 2013].

REFERENCES

1. Bradley, B.A., and Mustard, J.F. Identifying land cover variability distinct from land cover change, cheat grass in the Great Basin. *Remote Sensing of Environment*, **94**: 204–213 (2005)
2. Butera, M.K. Remote sensing of wetlands. *IEEE Transactions on Geoscience and Remote Sensing*, **3:** 383-392 (1983)
3. De Roeck, E.R., Verhoest, NEC., Miya, M.H., Lievens, H., Batelaan, O., Thomas, A. and Brendonck, L. Remote Sensing and Wetland Ecology: a South African Case. *Sensors*, **8 (5):** 3542-3556 (2008)
4. Deepa, R.S. and Ramachandra, T.V. Impact of Urbanization in the Interconnectivity of Wetlands. Paper presented at the National Symposium on Remote Sensing Applications for Natural Resources: Retrospective and Perspective (XIX-XXI), Indian Society of Remote Sensing, Banglore, India (1999)
5. Dewidar, K.M. Detection of land use/land cover changes for the northern part of the Nile delta (Burullus region), Egypt. *International Journal of Remote Sensing*, **25 (20):** 4079-4089 (2004)
6. Dottavio, C.L. and Dottavio, F.D. Potential benefits of new satellite sensors to wetland mapping. *Photogrammetric Engineering and Remote Sensing*, **50(5):** 599- 606 (1984)
7. Dubeni, N. and Debba, P. Classification of remotely sensed images, South African Statistical Association Conference, October, 27-31, Pretoria, South Africa (2013).
8. Ellis, E.C., Goldewijk, K.K., Siebert, S., Lightman, D., and Ramankutty, N. Anthropogenic transformation of the biomes 1700–2000. *Global Ecology and Biogeography*, **19:** 589–606 (2010)
9. Geist, H.J., and Lambin, E.F. *What drives tropical deforestation? A meta-analysis of proximate and underlying causes of deforestation based on subnational case study evidence* (LUCC Report Series 4), Louvain-la-Neuve: LUCC International Project Office (2001)
10. Houet, T., Loveland, T.R., Hubert-Moy, L., Gaucherel, C., Napton, D., Barnes, C.A., and Sayler, K. Exploring subtle land use and land cover changes: A framework for future landscape studies. *Landscape Ecology*, **25:** 249–266 (2010)
11. Hunsaker, C.T., O'Neill, R.V., Jackson, B.L., Timmins, S.P., Levine, D.A., and Norton, D.J. Sampling to characterize landscape pattern. *Landscape Ecology*, **9:** 207–226 (1994)
12. Ibharim, K. Assessment of Wetlands in Kuala Terengganu District Using Landsat TM. *Journal of Geography and Geology*, **1(2):** 33-40 (2009)
13. Jensen, J.R., Hodgson, M.E., Christensen, E., Mackey, H.E., Tinney, L.R. and Sharitz, R. Remote sensing inland wetlands: a multispectral approach. *Photogrammetric Engineering and Remote Sensing*, **52 (1):** 87-100 (1986)
14. Jensen, J.R. *Introductory digital image processing*. Prentice hall press, New Jersey, USA, (1996), p. 318.

15. Kiage, L.M., Liu, K.B., Walker, N.D., Lam, N. and Huh, O.K. Recent land cover/use change associated with land degradation in the Lake Baringo catchment, Kenya, East Africa: evidence from Landsat TM and ETM+. *International Journal of Remote Sensing,* **28 (19):** 4285-4309 (2007)
16. Lillesand, T.M., Kiefer, R.W., Chipman, J.W. *Remote sensing and image interpretation*. Fifth Edition, John Wiley, New York (2004)
17. Mitsch, W.J. and Gosselink, J.G. Wetlands, 3rd Ed. John Wiley & Sons, New York, (2000)
18. Ozesmi, S.L. and Bauer, M.E. Satellite remote sensing of wetlands. *Wetlands Ecology and Management,* **10 (5):** 381-402 (2002)
19. Sivrikaya, F.C., Kadiogullari, A.I., Keles, S., Baskent, E.Z., and Terzioglu, S. Evaluating land use/land cover changes and fragmentation in the Camili forest planning unit of north eastern Turkey from 1972 to 2005. *Land Degradation & Development*, **18:** 383–396 (2007)
20. Syphard, A.D. and Garcia, M.W. Human and beaver induced wetland changes in the Chickahominy River watershed from 1953 to 1994. *Wetlands,* **21**(3): 342–53 (2001).
21. Turner, B.L. Land-Use and Land-Cover Change: Advances in 1.5 Decades of Sustained International Research. *GAIA- Ecological Perspectives in Science, Humanities, and Economics*, **10:** 269–272 (2001)
22. Vitousek, P.M. Beyond global warming: Ecology and global change. *Ecology*, **75:** 1861–1876 (1994)
23. Work, E.A. and Gilmer, D.S. Utilization of satellite data for inventorying prairie ponds and potholes. *Photogrammetric Engineering and Remote Sensing*, **5:** 685-694 (1976)