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Buttonbush in Fruit - Photo by Matt Schweisburg

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Aim and Scope of Wetland Science and Practice

The *WSP* is the formal voice of the Society of Wetland Scientists. It is a quarterly publication focusing on news of the *SWS*, at international, national and chapter levels, as well as important and relevant announcements for members. In addition, manuscripts are published on topics that are descriptive in nature, that focus on particular case studies, or analyze policies. All manuscripts should follow guidelines for authors as listed for Wetlands as closely as possible. All papers published in *WSP* will be reviewed by the editor for suitability. Letters to the editor are also encouraged but must be relevant to broad wetland-related topics. All material should be sent electronically to the current editor of *WSP*. Complaints about *SWS* policy or personnel should be sent directly to the elected officers of *SWS* and will not be considered for publication in *WSP*.

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Editor's Message

Editor's Note

It's Monday morning, December 17, 2012, and I should have had the WSP out to print by now, but as usual, the December issue is running slow, mostly due to faults by the editor.

In this case, we're three days removed from the Newtown, Connecticut shootings. Anyone who has read the WSP over the years knows I have a couple of young kids, including one in the third grade – the same age as those kids in the Sandy Hook school. I'm still stunned and cannot fully comprehend what has happened. My thoughts and prayers go out to all the families affected. I truly hope no SWS member has had to endure that tragedy. Kids that age should be worried about whether they're going to get their feet muddy looking for frogs and toads, not about shootings in their schools.

In my case, I'll do what I can to comfort my kids and let them know there's still wonder and delight in this world, even in the face of unspeakable tragedies. There are cattails and red-winged blackbirds and tadpoles just waiting for us in the spring to remind us of life still to come. That's where I'm headed with my kids. May you find your own special place with yours.

Sadly,

Andy Cole
Editor WSP

WSP Deadlines: Wetland Science and Practice now has the following deadlines established for the submittal of materials. Thanks for your help.

For informational materials only, please observe the following submittal deadlines:

March issue:	March 1st
June issue:	June 1st
September issue	September 1st
December issue:	December 1st

For non-refereed articles, the following deadlines apply:

March issue:	January 15th
June issue	April 15th
September issue	July 15th
December issue	October 15th

Articles that are to be refereed may be submitted at any time. At this point, we hope to have a 3 month turnaround time for a decision and printing. It might, perhaps, be longer.

Historical Visualization Evidence on Forest-Salt Marsh Transition in Winyah Bay, South Carolina: A Retrospective Study in Sea Level Rise

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Abstract

Rising sea level is expected to impact low-lying ecosystems along the Southeastern and Gulf coasts in North America, converting freshwater-forested wetlands into salt marsh. In this study, we examined the transition from cypress-tupelo wetland, dominated with swamp tupelo, water tupelo, and bald cypress, to salt marsh in a middle section of Winyah Bay estuary in northeastern South Carolina, where relative sea level rise has averaged 3-4 mm/y since 1920. Using historical aerial photographs and geographic information system analysis, the rate of landscape change from forested wetland to tidal marsh was measured from 1949 – 2009 through three observable steps: death of tupelos, invasion of grasses, and death of cypress. Over the 60-year period, length of time explained 95% of the variation in marsh area. The marsh area in the studied site has increased from 1.72 to 6.74 ha (~ 300% increase) while the forested wetland has been decreased from 17.3 to 12.3 ha (29% loss). This paper demonstrates an application of historical aerial photographs as a retrospective method to examine the impacts of sea level rise in coastal wetland ecosystems.

Key Words
Coastal Wetlands, Cypress, Forested Wetlands, Swamp

Introduction

Sea level rise is an expected consequence of global warming. Eustatic sea level is expected to rise 0.48 m with a range between 0.11 and 0.77 m by 2100 (Church et al. 2001), although that estimation may be conservative and the range can be as large as from 0.5 to 1.4 m (Rahmstorf 2007). In either case, sea level rise under a changing climate is of a great concern to low-lying states in the southeastern United States with large coastal wetlands, including North and South Carolina (SC), Louisiana, Florida, and Texas. Low topographic gradients along river corridors and shallow groundwater tables lead to the formation of extensive bottomland hardwood forests and tidal freshwater forests along the South Atlantic coast (Conner et al. 2007). Sea level rise increases water levels and salinity in estuaries and encroaches upon these freshwater-forested wetlands. It has been estimated that approximately 58,000 km^2 of land along the Atlantic and Gulf coasts lies below the 1.5 m contour (Titus and Richman 2001). Predicting the rate of landscape change associated with rising sea level is valuable information to each of these states for identifying high-risk areas and implementing coastal protection plans.

In this paper we examine the impact of historic sea level rise on an interface of salt marsh and cypress-tupelo wetland adjacent to the Winyah Bay estuary in northeastern SC. Winyah Bay, a moderate sized estuary along the Atlantic coastline, has experienced significant impacts by geologically controlled long-term sea level rise. The boundary between the low-lying coastal forest and high marsh has moved up slope through time. Sandy forested spodosols are subjected to tidal inundation and salinization, and forest vegetation (e.g., *Pinus*, *Quercus*, and *Vaccinium*) is replaced by coastal salt marshes (e.g., *Juncus* and *Spartina*) (Gardner et al., 1992). The main goal of this examination is to determine how well simple topographic analysis identifies the observed landscape changes during this 60-year period with roughly 24 cm of relative sea level rise.

Materials and Methods

<u>Study Site</u>

Winyah Bay is a 65 km^2 estuary situated on the SC coast, 97 km northeast of Charleston (Lat 33d 19 m 13s N, Long 79d 15m11s W). It is roughly 22 km long and varies from 1.2 km wide at the entrance, to 7.2 km wide in mid bay, and 2 km wide at the confluence of Waccamaw and Pee Dee rivers (Patchineelam and Kjerfve 2004). The estuary receives flow from four rivers (Pee Dee = 88%, Waccamaw = 7%, Black = 5%, and Sampit <1%) at an average rate of 557 m^3/s and has an annual sediment load of 4.3 x 10^5 ton/

yr (Patchineelan et al. 1999; Goni et al. 2005). Relative sea level rise has been estimated at Charleston, SC, to be 3.15 ± 0.25 mm/yr for the period 1921-2006, and at Springmaid Pier, SC (about 30 km northeast of Winyah bay), at 4.09 ± 0.76 mm/yr for the period 1957-2006 (NOAA 2011). The estuary is separated from the Atlantic Ocean by the Waccamaw Neck Peninsula, an upland area of ancient beach deposits from 2-10 m in elevation. Strawberry swamp is the local name for small creek that enters the eastern side of Winyah Bay, 18 km upstream from the estuary mouth.

Aerial Photo Interpretation

The Baruch Institute retrieved prints from the US Department Agriculture archives for 1949, 1952, and 1963 and maintained these as an onsite archive. These 1:15840 scale prints were scanned at 400 dots per inch and converted to tagged image file (TIF) format digital files. These digital photographs had a pixel size of approximately 1m (3.3 feet). From 1965 until 1992 Clemson University departments of Forestry and Agricultural Engineering operated a Cessna 150 with a pod containing a World War II era, Zeiss 9x9 inch format aerial camera. A variety of films were used including: infra-red enhanced panchromatic (1970); panchromatic (1965, 1973, and 1978); false color infra-red (1975, 1980, 1989-1992); and true color (1982, 1983, 1984, 1985, and 1987). This plane flew at 1,829 m (6,000 ft) and produced prints of approximately 1:12000 scale. For this paper images from 1970, 1980, and 1990 were also scanned at 400 dots per inch (dpi) and converted to TIF format digital files. These digital photographs had a pixel size of approximately 0.76 m (2.5 feet). National Arial Photography Project (NAPP) digital ortho-photographs were available from the South Carolina Department of Natural Resources (SCDNR) server for 1994, 1999, and 2006 for this area (SCDNR, 2011). These digital photos were geo-referenced to the 1983 North American Datum (NAD83) with the Universal Transverse Mercator (UTM) Zone 17 projection. Finally, Georgetown County contracted for high resolution, pixel size of 0.15m (6 inches), ortho-rectified aerial photographs (NAD83, State Plane FIPS_3900) in February 2009. A digital copy of the area of interest was obtained from this photography (Georgetown County 2011).

For this comparison photographs were chosen to span time steps of approximately one decade (1949, 1963, 1970, 1980, 1990, 1999, and 2009). The 2006 NAPP ortho-photograph was chosen as the cartographic base and all others were rectified (or projected for 2009) to this base. Since much of the forest was over 100 years old, uniquely positioned tree crowns (e.g., in openings, at road intersections) were used as ground control points. Twenty such trees were identified on the 2006 ortho-photo to serve as ground control points. For each photograph 1 - 4 trees were chosen near the edges of Strawberry Swamp, along with others near the periphery of the photographs as ground control points. Since the appearance of each photograph varied (film type, sun angle, crab and tilt of airplane) a subset of 5 - 8 control points were chosen for each photograph that produced the smallest rectification errors. First order polynomial, nearest neighbor, and transformations were used to re-sample each photograph and root mean square (RMS) errors of up to 5 pixels were accepted for final rectifications.

Marsh and Tree Mortality Identification

Strawberry swamp presently consists of two vegetation types. The forested portion is a cypress-tupelo type with the major species swamp tupelo (*Nyssa sylvatica* var. *biflora*), water tupelo (*Nyssa aquatica*), and bald cypress (*Taxodium distictum*). The marsh section is dominated by cordgrass (*Spartina cynosuroides*), bulrush (*Scirpus robustus*), and cattails (*Typha angustifolia*, *Typha latifolia*). Three steps can be identified in the progression from cypress-tupelo forest to marsh grass: 1) death of swamp tupelos, 2) invasion of grasses, and 3) death of cypress. These steps can be identified in each of the photographic types. Marsh grasses appear as fine-grained light gray on panchromatic (e.g., 1948), light green or slightly brown on true color (e.g., 2009), and light blue on false color infra-red (e.g., 1980). Living deciduous trees, both cypress and tupelo, are light gray with a much coarse grain on panchromatic, blue-green on true color and blue on false color infra-red. In addition to coarser texture caused by crown and shadow, individual crowns can be distinguished even on winter photographs. The appearance of individual crowns and shadows of cypress and tupelo become smaller with the loss of fine branches within 12-18 months of mortality. Pines and evergreen hardwoods found on the uplands have similar coarse grain of crowns and shadows. They are darker gray on panchromatic, light to dark green on true color, and red on false color infra-red. Using these visual clues the progression appears as four zones: unchanged forest (appears as over 70% crowns); forest with high mortality and invading grass (appears as areas with 30-70% tree crown) (step 1 – death of tupelo); marsh of all grass and occasional tree survivors (less than 30% of the tree crowns remaining) (step 2 – invasion of grasses); and marsh of all grass (step 3 – death of cypress).

Polygons were digitized on each photograph (using ARC-GIS 9.3) to mark the extent of marsh, and area of high forest mortality. The westward edge of each polygon was marked by a small rice field dike and ditch on the 1949 photograph. The dike is still recognizable as a color change in the marsh in the 2009 photo and serves a straight-line boundary that was extended to the present mash edge. This straight edge was used to create a closed polygon of the boundary of marsh grass. The area of high mortality was digitized as an appended polygon to the marsh polygon by digitizing the boundary between recognizable mortality and the normally appearing forest.

Land Elevation

Land elevation data for the area, where aerial photographs were interpreted, were derived from Light Detection and Ranging (LIDAR) data flown by Airbourne 1 in 2003 at 1,372 m (4500 feet) altitude with a point spacing of 1.4 m, horizontal accuracy of 0.5 m and 95% of vertical points of 0.37 m. The data consisted of an ARC-VIEW point shape file of all last return points. These data were relative to the 1983 North American (horizontal) Datum (UTM zone 17N projection) allowing them to be directly compared to the aerial photographs. Elevation data were relative to the North American Vertical Datum of 1988. A single tile of LIDAR data encompassed the entire region of the aerial photographs. This file was intersected with each marsh polygon, digitized from the aerial photography series, to produce a point shape file of elevations. These individual files contained from 15800-27800 points depending on marsh size. Mean elevation and standard errors were calculated for the each set of LIDAR points corresponding to the marsh polygons.

Results and Discussions

Visual Evidences of Forested Wetland and Salt Marsh Transitions

Figure 1 a-g shows the progression of forest to marsh at Strawberry swamp at roughly one-decade intervals from 1949 to 2009. Freshwater forested wetlands with water salinity of 0.5 ppt or less are dominated by bald cypress, water tupelo, and swamp tupelo (Fig. 2a). The area can be found in point A in the 2009 aerial photo (Fig. 1g). Degraded sites have experienced moderate saltwater intrusion with salinity of 0.5 – 5 ppt (oligohaline). Some species progressively fall out of the vegetation assemblage as the canopy opens, leaving only bald cypress and a scattering of swamp tupelo (Fig. 2b). This area can be found in point B in Figure 1g. Salt marsh site is defined as having originally been freshwater wetlands that now receive saline water inputs with salinity of 18 ppt or less (mesohaline). All the hardwood species had died and been replaced with salt marsh vegetation (e.g. *Juncus* and *Spartina*) (Gardner et al. 1992). Stumps are still visible but are progressively covered by sediment accretion (Fig. 2c). This area can be found in point C in Figure 1g.

In 1949, areas of salt marsh and forested wetland were estimated at 1.72 and 17.3 ha, respectively, whereas the areas were expanded and encroached to 6.74 and 12.3 ha in 2009. Our calculation shows that there are 300% increase in salt marsh and 29% loss in forested wetland in the studied site in the last 60 years. Although the rate of marsh expansion is not uniform, a couple of trends are apparent. The marsh tended to expand into the area that was identified to have had enhanced mortality the decade before. Although a few trees held on for several decades, most notably the group of trees near the center of the 1949 marsh, survivors tended to disappear within two decades after mortality was first observed.

Table 1 presents the results of GIS analysis performed on the polygons digitized in Figure 1. The area of marsh steadily increased with the smallest increase from 1970 - 80 (i.e. 0.01 ha) and the largest from 1999-2009 (i.e. 2.36 ha). Between 1949 and 1980 (Figures 1a - d) marsh expansion was primarily within

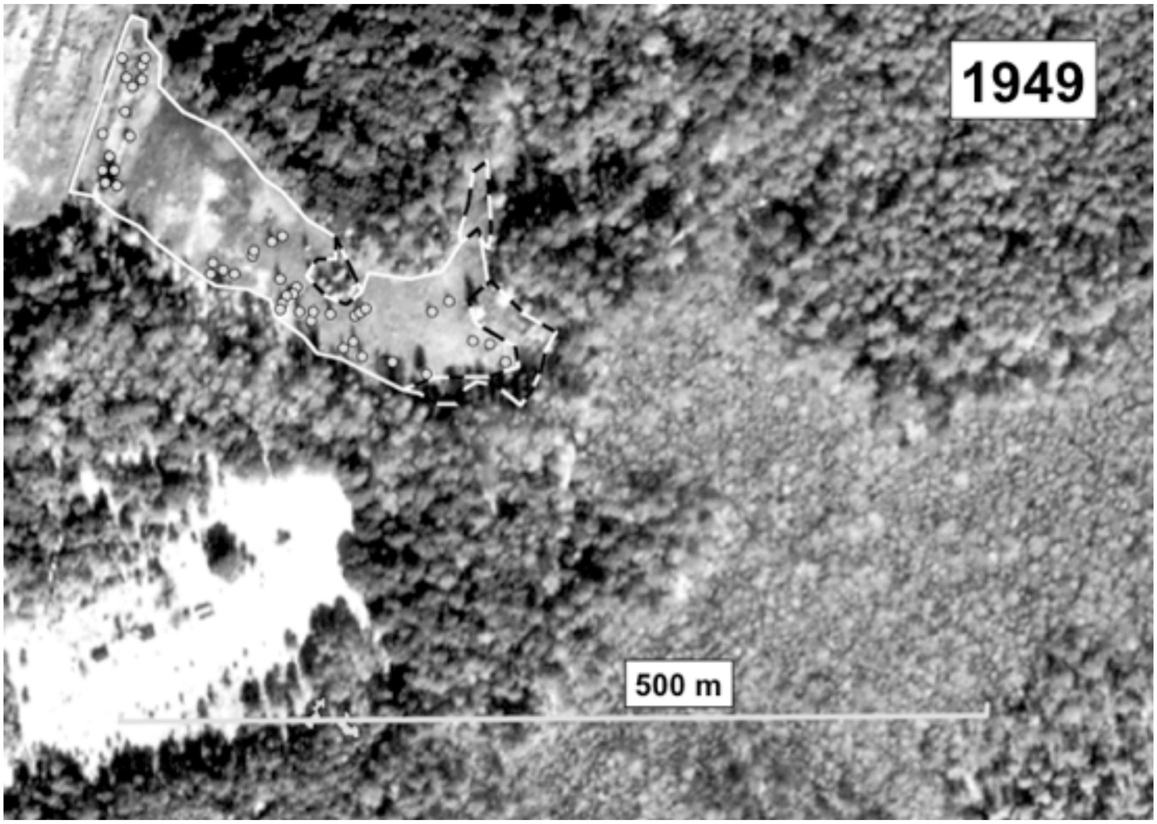

Figure 1a: Shows the forest-marsh landscape in 1949. The white line represents marsh edge (Steps 1 - death of tupelo and Step 2 - invasion of grasses), and the dashed line represents edge of enhanced mortality (Step 3 – death of cypress). White dots within the lines show the surviving trees (probably cypress) in marsh.

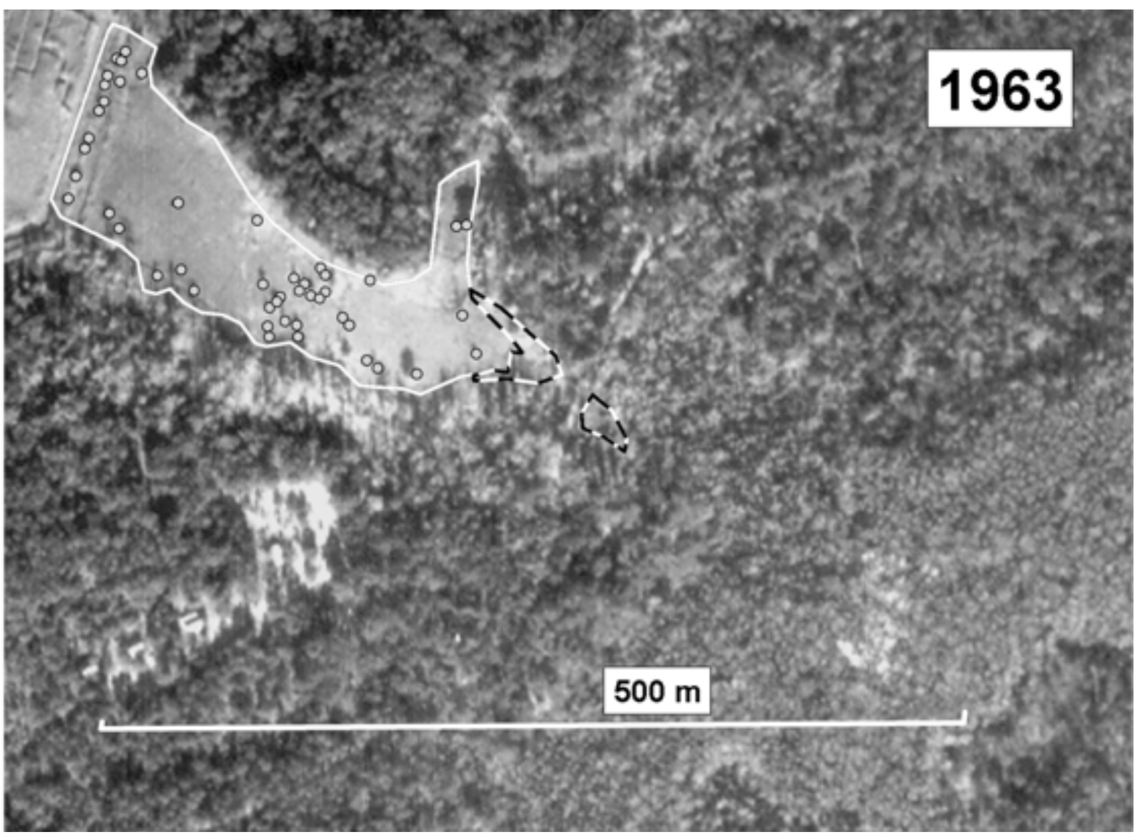

Figure 1b: Shows the forest-marsh landscape in 1963. The white line represents marsh edge (Steps 1 - death of tupelo and Step 2 - invasion of grasses), and the dashed line represents edge of enhanced mortality (Step 3 – death of cypress). White dots within the lines show the surviving trees (probably cypress) in marsh.

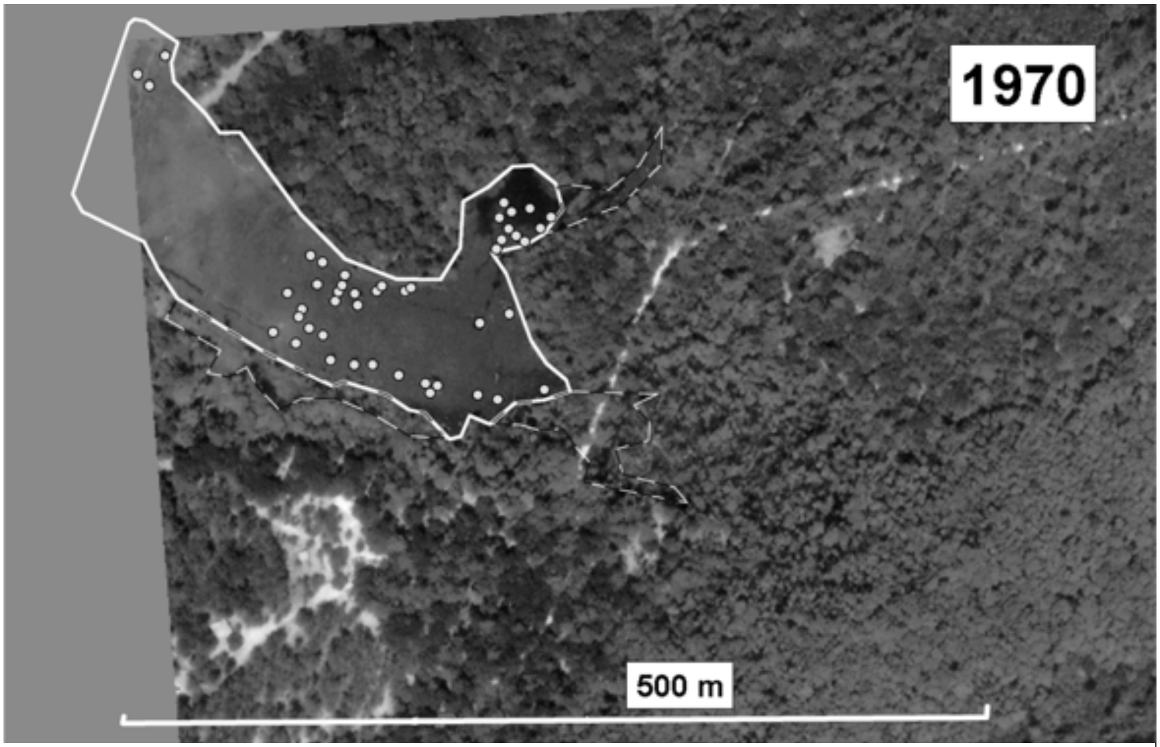

Figure 1c: Shows the forest-marsh landscape in 1970. The white line represents marsh edge (Steps 1 - death of tupelo and Step 2 - invasion of grasses), and the dashed line represents edge of enhanced mortality (Step 3 – death of cypress). White dots within the lines show the surviving trees (probably cypress) in marsh. The line at the bottom of each figure is a 500 m mark for comparison purpose. Aerial photos taken from different angles are rectified to the same orientation and scale.

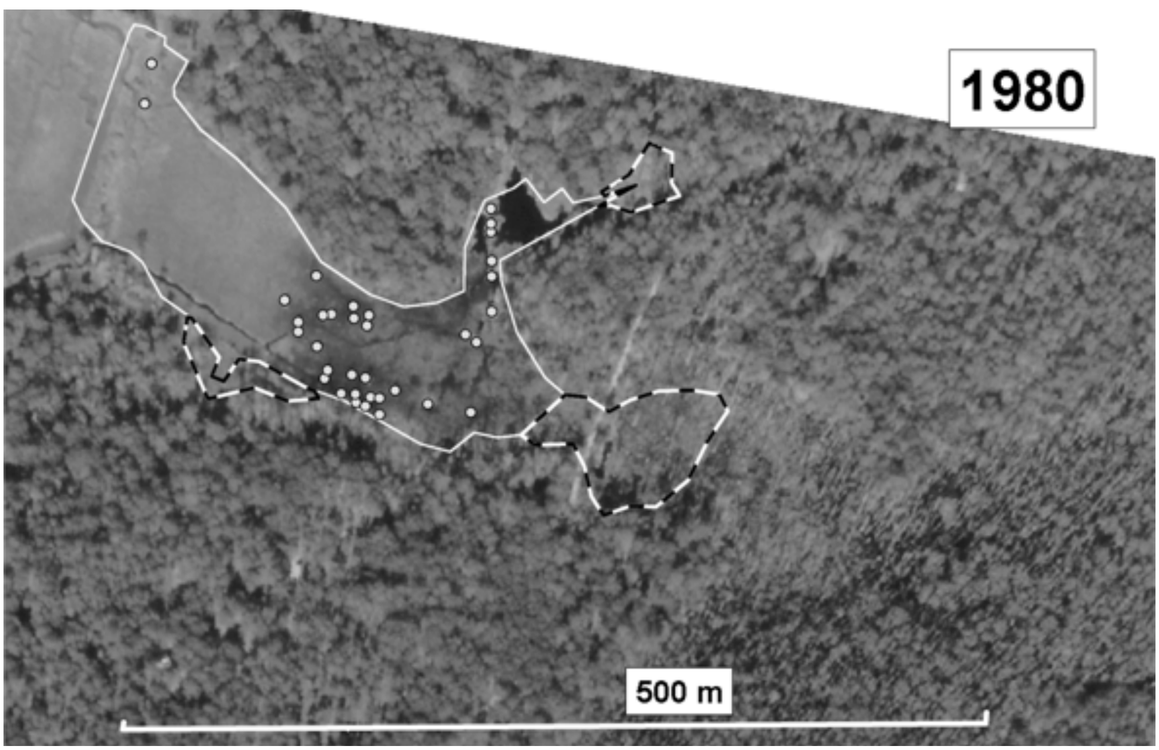

Figure 1d: Shows the forest-marsh landscape in 1980. The white line represents marsh edge (Steps 1 - death of tupelo and Step 2 - invasion of grasses), and the dashed line represents edge of enhanced mortality (Step 3 – death of cypress). White dots within the lines show the surviving trees (probably cypress) in marsh. The line at the bottom of each figure is a 500 m mark for comparison purpose. Aerial photos taken from different angles are rectified to the same orientation and scale.

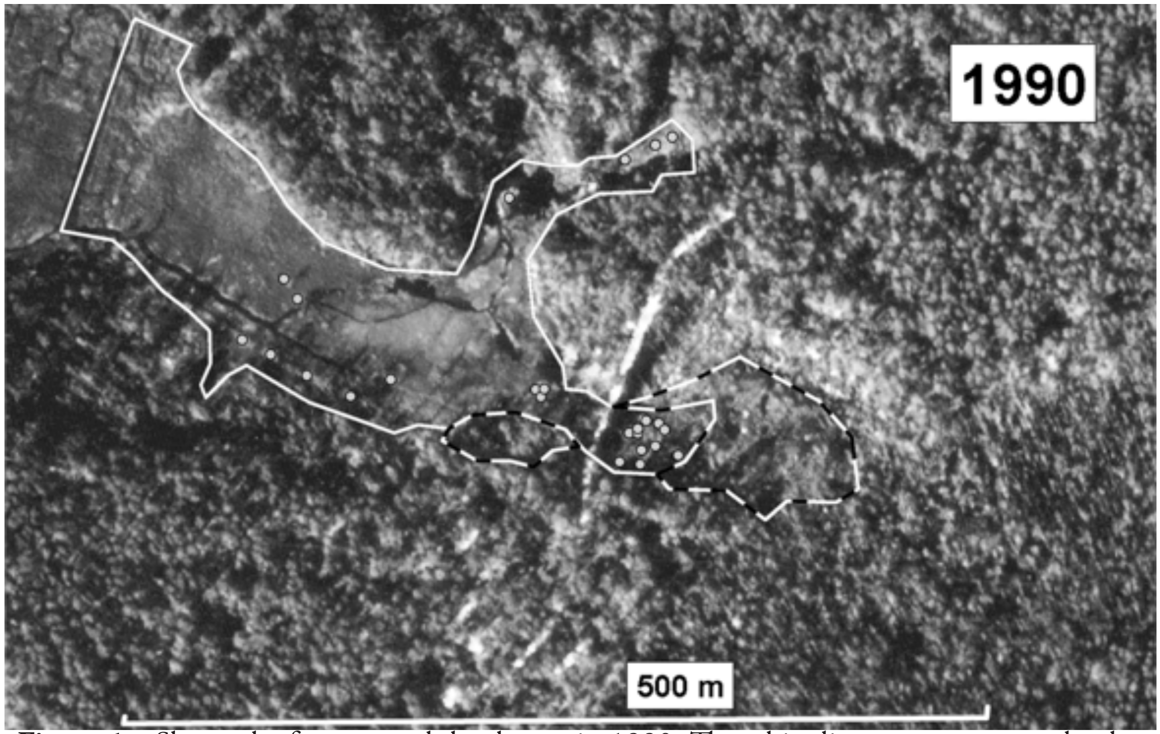

Figure 1e: Shows the forest-marsh landscape in 1990. The white line represents marsh edge (Steps 1 - death of tupelo and Step 2 - invasion of grasses), and the dashed line represents edge of enhanced mortality (Step 3 – death of cypress). White dots within the lines show the surviving trees (probably cypress) in marsh.

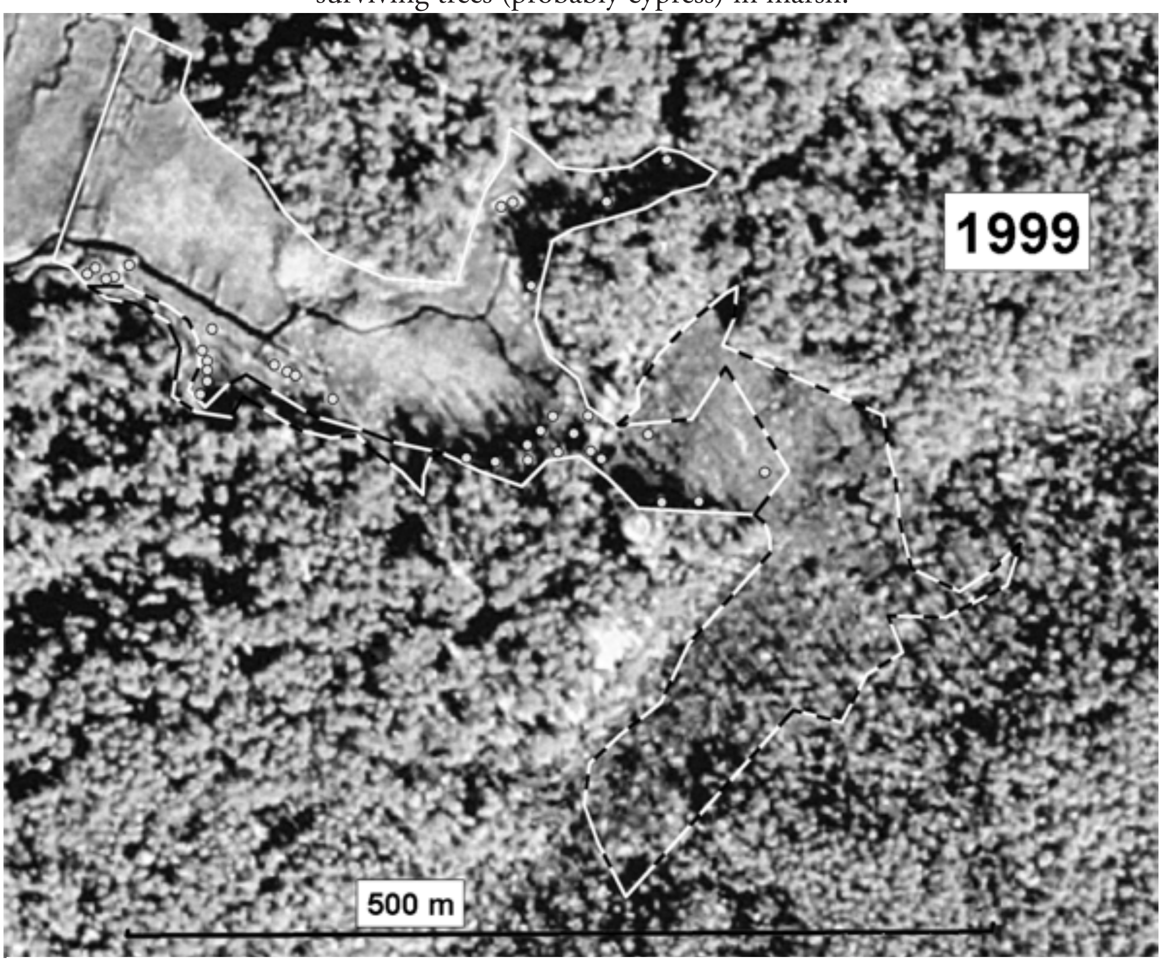

Figure 1e: Shows the forest-marsh landscape in 1999. The white line represents marsh edge (Steps 1 - death of tupelo and Step 2 - invasion of grasses), and the dashed line represents edge of enhanced mortality (Step 3 – death of cypress). White dots within the lines show the surviving trees (probably cypress) in marsh.

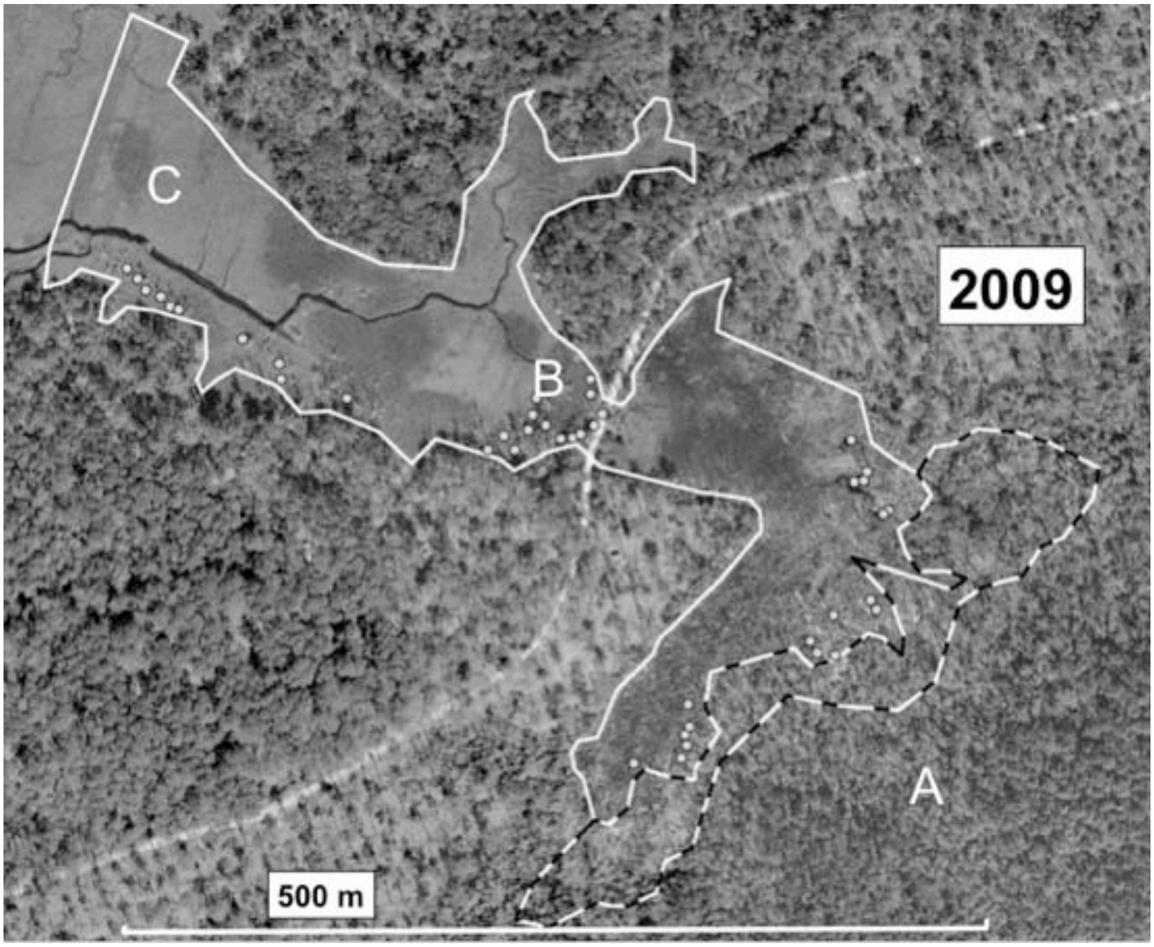

Figure 1g: Shows the forest-marsh landscape in 2009. The white line represents marsh edge (Steps 1 - death of tupelo and Step 2 - invasion of grasses), and the dashed line represents edge of enhanced mortality (Step 3 – death of cypress). White dots within the lines show the surviving trees (probably cypress) in marsh. Point A, B, and C indicated freshwater forested wetland, degraded sites, and salt marsh as in Figure 2, respectively.

Figure 2a: Forested wetland, photo taken at point A in Figure 1g.

Figure 2b: Degraded wetland, photo taken at point B in Figure 1g.

Figure 2c: Salt marsh, photo taken at point C in Figure 1g, respectively.

a single valley between ancient dunes. After 1980, the marsh expanded into the confluence of three tributaries and has begun to advance into each of them (Figures 1e - f). Marsh progression did not seem impacted by the presence of the Hobcaw road, with mortality first crossing the road in 1963 (Figure 1b) and marsh crossing the road in 1990 (Figure 1e).

<u>Expansions of Salt Marsh</u>

The data in Table 1 show a steady increase in marsh size over the 60-year period. A simple regression of time and marsh size indicates a steady, exponential expansion of marsh size over time and explains over 95% of the variation in marsh size. ($y = 1.59e^{0.0216x}$, $r^2 = 0.95$, $p < 0.01$; where y is area in hectares and x is number of years since 1949). This steady increase is also supported by the area of enhanced mortality. Marsh size is well predicted by the size of marsh plus mortality a decade earlier ($y = 1.13x - 0.390$, $r^2 = 0.96$, $p < 0.01$, where y is marsh area at present and x is area of marsh plus mortality in the previous decade in hectares). While the overall progression is well predicted by time and presumably by sea level, there are noticeable differences in some decades.

Area (ha)				Evelation of Polygons in 2003 (cm NAVD 1988)		
Year	**Marsh**	**Mortality**	**Total**	**Maximum**	**Mean**	**Standard Error of Mean**
1949	1.72	0.306	2.026	168	52.1	0.195
1963	2.13	0.139	2.269	166	50.1	0.184
1970	2.7	0.632	3.332	177	49.6	0.184
1980	2.71	0.721	3.431	178	50.5	0.194
1990	3.56	0.726	4.286	206	53.2	0.185
1999	4.38	2.973	7.353	243	56	0.183
2009	6.74	1.834	8.574	306	64.6	0.244

Table 1: Areas of marsh and forest mortality interpreted polygons for each year of photography and elevations of those areas derived from 2003 LIDAR points within each marsh polygon.

Between 1970 and 1980 the overall trend greatly over predicts the actual small change in marsh area while in 2000-2009 the trend under predicts the change in area.

There has been a clear progression of marsh into the forested wetland at strawberry swamp during the past 60 years. Throughout that period there has been a steady rise of relative sea level along this portion of the SC Coast. This rise is part of a geologic relative sea level rise that has been occurring for the last 6,000 years (Gardner and Porter 2001; Sharma et al. 1987) in the nearby North Inlet Marsh. This geologic setting provides an ideal area for a retrospective examination of the progression of forest to marsh under a rising sea level. The local rate of rise (3-4 mm/y) is in similar to the lower estimates of general sea level rise for the next century (Church et al. 2001), suggesting that historical changes in Strawberry Swamp may be instructive in making predictions about future impact of sea level rise on coastal wetland ecosystems.

<u>Management and Practical Implications</u>

This study demonstrates an application of historical aerial photos and LIDAR data to examine the impacts of sea level rise on coastal wetland ecosystems. In particular, results of this study show that the marsh size at any time could be predicted by the area of marsh plus enhanced forest mortality a decade earlier. In other words, the expansion of salt marsh in a coastal ecosystem could be simply estimated by examining the current areas forest dieback. The advantage of this retrospective method provides an understanding of long-term effect of sea level rise in regional coastal wetland ecosystems and the cost for this examination should be minimal. Aerial photos and LIDAR data could be available from the U.S Department of Agriculture, state, county, or local city offices.

Summary

Strawberry swamp is a small watershed that happens to be located along Winyah Bay slightly seaward of the normal 1 ppt brackish boundary and slightly landward of the estuarine turbidity maximum zone. Between 1949 and 2009 the area of marsh expanded from 1.72 to 6.74 ha corresponding to the sea level rise. The rate of marsh expansion was well explained (> 95%) by an exponential equation using years since 1949 as the known variable. An increase loss of forested wetland to salt marsh in strawberry swamp is expected with the continued increase in sea level rise.

Acknowledgments

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Wetland Plant Therapy: An Alternative Medicine for Traditional Health Care in Odisha, India Taranisen Panda

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Introduction

Wetlands are perhaps the most interesting landscapes in the world to have earned global importance during the last few decades. They are being considered all round the world in the issues of environmental protection, eco-restoration, pollution control, and biodiversity conservation. The values of each wetland are intimately linked with its location and the cultural status and socioeconomic needs of the people who use it. The importance of wetlands to the global carbon cycle, water balance, wildlife, biodiversity, human food and medicine production is much greater than their proportional surface area on earth.

Worldwide, ten thousands of species of higher plants and several hundred lower plants are currently used by human beings for a wide variety of purposes such as food, fuel, fiber, oil, herbs, spices, industrial crops and as forage and fodder for domesticated animals (Heywood 1992). Many Indian plants and their constituents are the chief ingredients of a number of pharmaceutical preparations used in various ailments, on account of their high antibacterial and antimicrobial activities (Kirtikar and Basu 1991). Many plant species, possessing medicinally important compounds are disappearing at an alarming rate due to the destruction of their natural habitats caused by rapid agricultural development, urbanization, indiscriminate deforestation and uncontrolled collection of plant materials.

Odisha, one of the eastern states of India, has one of the oldest and richest cultural traditions of using wetland plants for medicinal purposes. The rural people of the state still depend on the traditional ethnomedicine for their day-to-day primary health care. These medicinal plants gain further importance in the region where modern medical health facilities are either not available or not easily accessible.

Of the pharmacologically active principles found in plant kingdom, terrestrial plants are arguably the most important group. Intensive studies concerning ethnomedicinal uses of terrestrial plants of Odisha has earlier been highlighted (Mudgal and Pal 1980; Saxena et al. 1988; Girach et al. 1998; Nayak et al. 2004; Panda et al. 2005; Pandey and Rout 2006; Rout et al. 2009; Sahoo and Satpathy 2009; Panda 2010). The use of aquatic/wetland plant species as remedies, although representing an important component of traditional medicine has hardly been studied (Panda and Mishra 2011). It is especially true in case of the Kendrapara district with around 642,273 ha of wetlands which is almost 5% of the total state wetland area. Many wetlands including several small and large rivers systems, creeks, numerous natural and man made canals and ponds are distributed in the district. Traditionally the local inhabitants have been using wetland plants against the diseases they suffer from. So an attempt has been made to collect ethnomedicinal information on wetland plants to treat common diseases on the basis of field surveys and taxonomic identification of plants available in Kendrapara district of Odisha, India during 2009-10.

Materials and Methods

Study area

The Kendrapara district (20º 21'- 20º 47'- N and 86º 14' - 87º 03'- E) is located (Figure 1) in the coastal part of Odisha (=Orissa), India. The study was carried out in different villages of the districts during 2009-2010. The villages were selected basing upon the following criteria (i) rural-based having rich wetland biodiversity and (ii) the traditional health system of the people is mostly based on the plants available in the locality. The climate of the district is warm and humid. Three distinct seasons are felt during the year: rainy season (June until October), winter (November until February) and summer (March until June). The annual rainfall varies from 1500 mm to 1550 mm and temperature ranges from 17° to 48°C. Periodic earth tremors, thunder storms and dust storms in April and May are further characteristic features of the districts.

The field study was carried out from August 2009 to September 2010, and information on the use of medicinal plants was obtained through structured questionnaires, complemented by free interviews and informal conversations (Huntington 2000). The interviews were individually carried out and, during the first contacts with the local population, "native specialists" were identified. These were people who consider themselves, and are considered by the community, as having exceptional knowledge about the use of plants. Eighty-seven (68 men and 19 women) people were interviewed. Among these interviewees, 10% were aged 21-40 years, 40% were 61 years old or more and half of the sample (50%) were in the 41-60 age range. Surveys were conducted in different villages of the district.

Medicine men, Kaviraj, experienced and aged persons, local healers of the villages were consulted for recording local name; parts of plants used, methods of drug preparation and recommended doses. Personal interviews

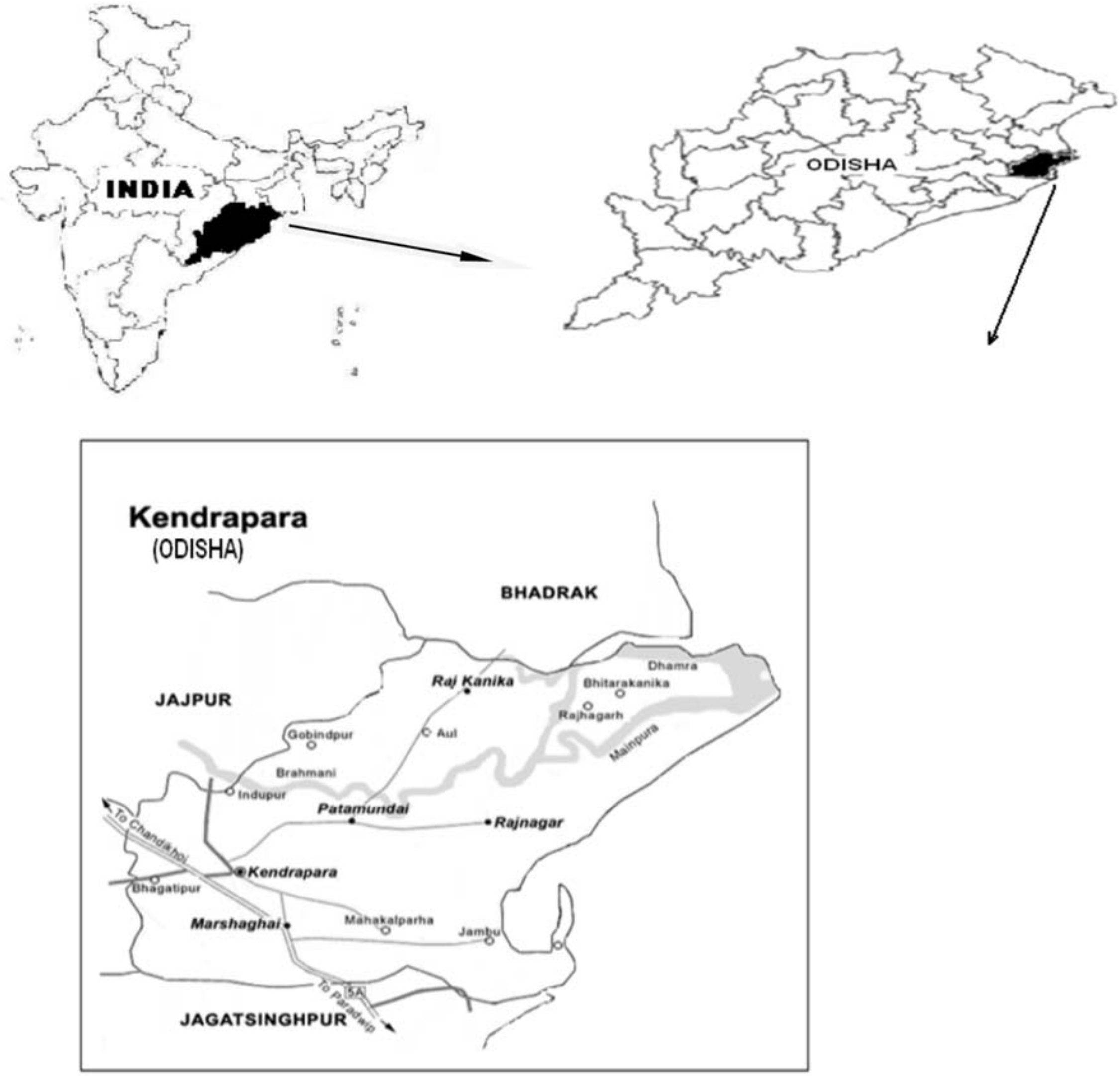

Figure 1: Map of the study site in Odisha, India.

and group discussions with local inhabitants revealed some very valuable and specific information about the plants, which were further authenticated by crosschecking. In addition to crosschecking and recording folk names of plants through collecting voucher specimens, it was important to crosscheck information with different people and compare the results from different methods (Cunningham 2001). Interviews with people out of the village were conducted on a systematic basis to know more details about species, their management and distribution.

The collected specimens were processed, dried and herbarium specimens were prepared. Voucher specimens of the collected plant species were deposited in the herbarium of the Department of Botany, Chandbali College, Chandbali. A voucher specimen facilitated the identification of the species encountered during the research and permitted colleagues to review the results of the study (Jain and Goel 1995). We consulted several sources for identification of species: Haines (1921-25), Saxena and Brahmam (1994-1996) and Kirtikar and Basu (1991).The medicinal plants collected are listed here with their botanical names followed by family name, their local names in Oriya if any and the parts used for medicinal purpose.

Results

The study revealed that the inhabitants of Kendrapara district have sufficient knowledge about ethnomedicinal uses of wetland plants growing in their surrounding. We found that twenty two plant species comprising eighteen families were used for medicinal purposes in the surveyed area. The most important families were: Amaranthaceae, Araceae, Asteraceae and Nympheaceae. The medicinal parts, leaf, flower, seed, stem, root, rhizome and whole plant were used in raw or processed forms (Table 1). The most cited treated diseases were: cough and cold, cardiovascular, diabetes, epilepsy, fever, gonorrhea, rheumatism and skin. The data collected show that majority of medicines were taken orally. Some of the reported preparations were drawn from a mixture of plants. The percentage of use of aerial plant parts were higher (80%) than that of underground parts (20%).

Discussion

Nature was man's earliest source of vital medicine which has provided a continuous source of raw materials used for treating all his ailments. In contrast to modern allopathic method, the traditional knowledge which is developed through experience of mankind is potential source for the development of drugs against variety of diseases. The present report on the use of aquatic plants for medicinal purposes draws support from earlier studies in different parts of India (Biswas and Calder 1954; Jain 1965; Majid 1986; Gupta et al. 2005). The studied wetland plants are also reported in different districts of south Odisha (Panda and Mishra 2011). Moreover, these reports differ in the parts of the plant used or in preparation and mode of use (Jain 1991).

The local people inherit rich traditional knowledge about the medicinal uses of flora investigated and apply this knowledge for making crude medicines to cure infections, as well as a number of ailments from simple cold to other complicated diseases. Traditional knowledge forms the basis for origin of not only alternative medicine but also paved way to evolution of a gamut of new and novel modern medicines. This knowledge is mostly unknown to scientific world and faces a slow and natural death.

The catalogued plants in the present study are common in the surveyed area, this way it is evidenced that the flora composition of Kendrapara district influences the choice of medicinal plants use. A similar tendency was reported by Adeola (1992) who observed that the species used for preventive and healing medicine were associated with the natural area in which the users live, as well as with their relative species abundance.

Conclusion

The present study indicates that wetland medicinal plants associated with rivers, ponds and other aqueous systems are unique to the indigenous medicinal knowledge of the locality under study. Plants are still the major source of medicine for a variety of diseases like cardiovascular, bronchitis, skin allergies, and inflammatory conditions to the people in the surveyed area. Considering the importance of plant species in different wetlands, it is concluded that the conversion of natural wetlands to different land uses leads to the loss of many medicinal species. Conservation measures, a proper management and utilization of wetland can ensure maintenance of the biological stability as well as a healthy ecosystem service to the society.

Acknowledgements

The author expresses deep sense of gratitude to the rural people who cooperated and shared their knowledge concerning the traditional ethnomedicinal practices in Kendrapara district of Odisha.

Voucher No.	Family	Botanical Name, Author and Local name	Parts Used	Disease/ Condition	Mode of Application
KT-41	Acanthaceae	*Hygrophila auriculata* Schum.Heine, 'Koelikhia'	Leaf	Abdominal pain, urinary infection	Leaf extract is taken orally for abdominal pain and urinary infection. Powdered leaves are taken twice a day for a week against bronchitis and cough
KT-107	Amaranthaceae	*Alternanthera philoxeroides* Mart. Grises,'Ghoda madaranga'	Young shoot	Cough	4-5 young shoots are ground with black pepper and taken orally to cure acute cough.
KT-111	Amaranthaceae	*Alternanthera sessilis* R.Br., 'Madaranga'	Leaf, root	Headache, blood pressure	1-2 tea- spoonful of leaf juice is taken for headache, blood pressure and leucorrhea. Root juice is used as nasal dropper.
KT-84	Amarylladaceae	*Crinum latifolium* L., Amarylladaceae, 'Pani kenduli'	Root	Night blindness, diabetes	One teaspoonful of root juice is taken before breakfast.
KT-78	Anacardiaceae	*Hydrilla verticillata* (L.f) Royle, 'Chingudia dala'	Whole plant	Joint pain	Whole plant is slightly warmed and tied on the affected area.
KT-86	Apiaceae	*Centella asiatica* L.Urban., 'Thalkudi'	Leaf	Indigestion	3-4 fresh leaves are taken in empty stomach early in the morning before breakfast.
KT -17	Araceae	*Lasia spinosa* (L.) Thw, 'Panisaru'	Stem (modified)	Stomach disorder	The curry of modified stem with curd is useful for digestion and stomach disorder.
KT-13	Araceae	*Pistia stratiotes* L., 'Borjhanji'	Whole plant	Rheumatism, leprosy, eczema	Whole plant is warmed and tied at the inflamed area to reduce swelling. Leaf juice with coconut oil is used to treat leprosy and eczema.

Table 1: Ethno-medico profile of wetland plants of Kendrapara district

Voucher No.	Family	Botanical Name, Author and Local name	Parts Used	Disease/ Condition	Mode of Application
KT-18	Asteraceae	*Enhydra fluctuans* Lour., 'Hidmicha'	Leaf	Gonorrhea	Half cup of infusion of leaves is drunk as a remedy against gonorrhea. Leaf paste prepared with castor oil is applied on paining legs. Pure mustard oil mixed with leaves juice is given to cure headache. Leaves juice mixed with honey is given three times a day in cough.
KT-93	Asteraceae	*Grangea maderaspatana* L.Poir., 'Paijhari'	Leaf	Stomach problem	7-8 young leaves are ground and the extracted juice is taken with sugar.
KT-47	Boraginaceae	*Heliotropium indicum* L., 'Hatisundha'	Leaf	Insect bites	Fresh leaves are crushed and applied externally for insect bites.
KT-103	Commelinaceae	*Commelina benghalensis* L., 'Kansiri'	Leaf	Boils	Warm leaf is applied around boils as suppurate.
KT-117	Convovulaceae	*Ipomea aquatica* Forssk., 'Kalama'	Leaf	Gonorrhea	Leaf juices along with cow ghee are used for gonorrhea and also act as blood purifier.
KT-129	Cyperaceae	*Cyperus rotundus* L. 'Mutha'	Rhizome, leaf	Pneumonia	The tuber paste mixed with honey is given internally to heal ulcers. Rhizomes, tender leaves and equal amount of Piper nigrum are made into paste with water to cure pneumonia. One tea spoon of dried rhizome powder is taken every day to cure acidity and other stomach diseases

Table 1 cont'd: Ethno-medico profile of wetland plants of Kendrapara district

Voucher No.	Family	Botanical Name, Author and Local name	Parts Used	Disease/ Condition	Mode of Application
KT-54	Fabaceae	*Aeschynomene aspera* L., 'Solo'	Aerial part	Cough and cold fever	1-2 teaspoonful of young shoot juice is given to cure cough and cold fever.
KT-31	Linaceae	*Trapa natans* L., 'Pani singada'	Leaf	Rheumatism	Leaf powder is taken orally for rheumatism. Leaf juice is used for stomach disorder.
KT-47	Marsileaceae	*Marsilea quadrifolia* L., 'Sunsunia'	Leaf	Headache, blood pressure	Leaf extract is taken with sugar for headache and blood pressure.
KT-51	Menyanthaceae	*Nymphoides indica* Kuntze, 'Panisimili'	Leaf	Epilepsy, rheumatism	Leaf paste is taken orally to cure epilepsy and rheumatism. Plant decoction is drunk to cure fever and dysentery.
KT-66	Molluginaceae	*Glinus oppositifolius* (L.) A.DC.,'Pitasaga'	Whole plant	Skin	Whole plant is used either in raw or cooked form to cure various types of skin disease like scabies, itches etc.
KT-29	Nympheaceae	*Nelumbo nucifera* Gaerntn., 'Padma'	Flower, seed	Diarrhea	Flower petal decoction is useful for diarrhea. A sweet prepared from its seed floor is given as cardio-tonic after child birth.
KT-48	Nympheaceae	*Nymphaea pubescens* Wild., 'Dhala kain'	Rhizome	Dysentery	Paste of rhizome is taken in morning to treat dysentery. Seeds are soaked overnight and the water is drunk to cure diarrhea.
KT-16	Scrophulariaceae	*Bacopa monnieri* L., Pennel, 'Brahmi'	Whole plant	Cardiac, memory power	Leaf paste or juice is taken orally for blood pressure and to increase memory power.

Table 1 cont'd: Ethno-medico profile of wetland plants of Kendrapara district

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Letter to the Editor

On occasion, I receive a letter concerning some aspect of Wetland Science and Ecology. The following, very polite exchange refers to Stribling's article in the September 2012 WSP (lightly edited). I can't imagine a better (and nicer) way to help and discuss. Thanks to Timothy and Judith.

Andy

Dear. Mr. Cole and Dr. Stribling:

Letter to Editor, Wetland Science and Practice: "An Improved Simple Device for Measuring Elevation Changes in Wetlands."

Good article in Wetland Science and Practice. Used similar myself over the years. One detriment mentioned by Dr. Stribling is loss of water from the long U-tube during field use.

An improved version: On each end of the clear liquid tube install the following:

1. 1/4-inch threaded brass plug with 1/16-inch hole drilled through it top to bottom;
2. 1/4-inch brass quarter-turn ball valve ('plumbing' style with 'L' handle for ease of use);
3. 1/4-inch threaded brass hose barb fitting (sometimes known as 'King' nipple) as used in repair splicing of service station air hose. Attach the 1/4-inch inside diameter clear tubing to the barbed fitting by heating end of hose in hot water and pushing fully onto the barbed fitting screwed into the valve.

I've never needed a clamp at the hose connection. Drilled hole vent in brass plug allows system to equalize with atmospheric pressure. User can close valves and move without losing liquid from hose.
Can add food color to water in tube to better see meniscus.

The entire assembly can be rolled up with valves closed and stored for next use without draining (I add a few milliliters of household bleach to the water to prevent biological growth).

For occasional construction needs to 'shoot' an elevation around a corner I've used this same assembly but substituted plain water hose (with appropriate connections) with only a few feet of clear tubing on each end.

I recommend brass instead of steel to prevent corrosion problems. The 1/4-inch valves are the most expensive component, assuming you have the clear tubing available.

Total cost is probably $5 or less for each end assembly. Any good plumbing wholesale supply house would have these common parts. I suspect Lowe's or Home Depot would similarly.

Contact me if I may assist.

Yours in Wetlands on behalf of the Regulatory Office, Tulsa District, Army Corps of Engineers;

/s/ Timothy Hartsfield PE &tc
918-669-7237
Senior Regulatory Project Manager
Regulatory Office
Tulsa District
United States Army Corps of Engineers

Just a note: we don't actually lose water using our simple bottle cap arrangement, but inattention can lead to this if a student hasn't remembered to close the cap. But this alternative sealing device might be a good option to consider also!

I just looked at this again and realized I didn't explain the clamping system we use in the article. So, you might (if this hasn't already been processed) explain that this is just a pop-top bottle cap with the small end inserted into a piece of rubber tubing that is the O.D. of the water level tubing. The other end of the rubber tubing is fastened over the water level tubing with a plastic wire tie. It's very inexpensive, quick to release and close, and does not leak.

Thanks,
Judith

I'd like to add one aspect that may make the improved version slightly easier to use in the field, especially if by less experienced students of any age.

When assembling the brass valve and fittings I have found it best to orient the threaded fittings into the valve body such that the valve handle in the closed position (90-degrees to the valve body) can be used as a handy handle pulling toward 'closed' while moving rather than inadvertently 'opening' the valve while walking.

Envision if you will two people using the liquid level. They change location and in doing so 'close' the valve to save water. Each tends to grasp the 'closed' valve handle and start walking. With forethought and considered orientation of the valve handle, holding the handle while moving--with the tube dragging behind-- will tend to maintain the valve in the 'closed' position.

Assembly in this manner also allows the valve handle when in the 'open' position to become a handy hanger, perhaps with a stake wedged between the valve body and the valve handle.

One last: the brass plug (plastic works fine but 1/4-inch threaded plastic fittings may not be commonly available to all readers) does not have to be overly tight. In a set of two valves, I tend to 'bump' one plug with a wrench and leave the other finger-tight for easy addition of water as needed.

Contact me if I may assist in any way.

Again, thank you for your efforts on my behalf.

Sincerely,
Timothy Hartsfield

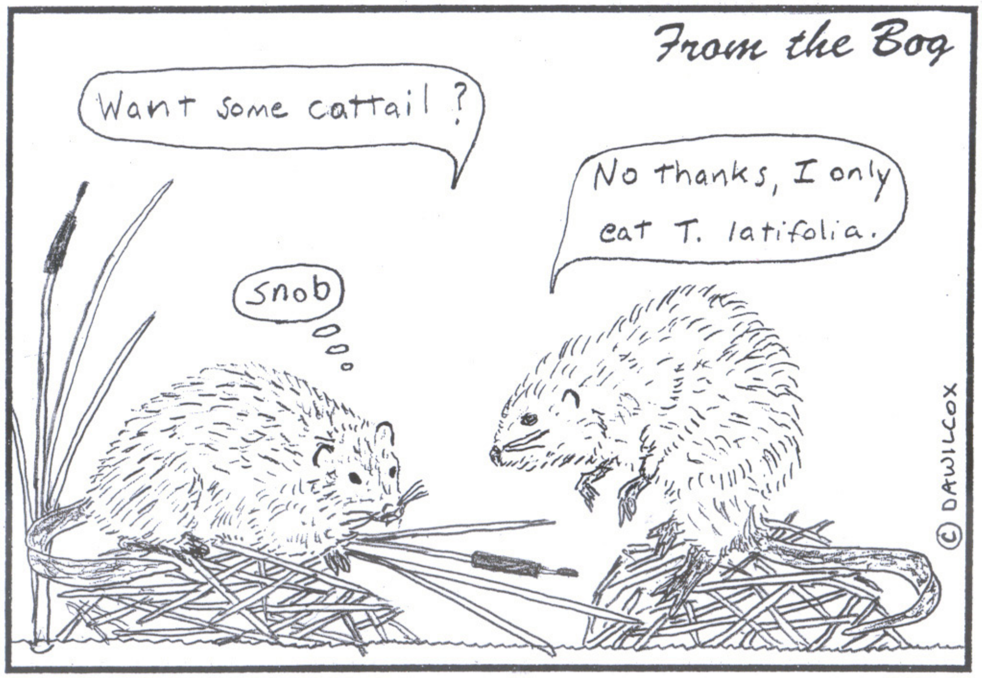
2013 SWS Awards Announcement

Know an SWS member who has made a real impact in wetland science research, restoration or conservation? Perhaps you want to recognize someone for his or her dedication and service to SWS over the years. Consider nominating these special people for the 2013 Fellows, Merit or Lifetime Achievement awards. Please note that the International Fellow Award, which alternates with the Lifetime Achievement Award, is not being offered in 2013.

- The Lifetime Achievement Award is presented to individuals in honor of a distinguished and extensive career of consistent meritorious contributions to wetland science and management.
- The Merit Award is presented to an individual in recognition of an outstanding piece of original research, achievement, or contribution to wetland science.
- Fellow is the highest recognition of membership bestowed by the Society, awarded for outstanding personal or professional achievement in an area of specialization whether in research, teaching, management, service, or administration and whether in public, commercial, or private service activities.

Visit the SWS website (http://www.sws.org/awards_grants/index.mgi) for complete award descriptions, nomination instructions and a listing of past award recipients. Nominations for all three awards are due no later than Friday, 15 February 2013 and must be submitted to Greg Noe (gnoe@usgs.gov), Chair of the SWS Awards Committee. Recipients will be recognized at the 2013 annual SWS meeting, June 2-6, in Duluth, Minnesota.

Stay tuned for a more detailed announcement regarding the 2013 Student Research Grants competition, which will provide up to $1,000 in financial support to the best student conducted wetland related research. Applicants must be an active SWS member conducting undergraduate or graduate level research in wetland science at an accredited college or university worldwide. In the meantime, contact Dianna Hogan, Chair of the Student Grants Subcommittee, at dhogan@usgs.gov with questions.



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