

**Ecosystem integrity and community participation related to water
availability within and around Calakmul Biosphere Reserve**



Prepared by Dení Rayn PhD¹

2009

¹Contact details: drayn@yahoo.com

Front cover photo: Panoramic view of Calakmul Biosphere Reserve from Structure II in Calakmul archeological site (by Dení Rayn)

Table of contents

Intro.....	2
Study site.....	2
Vegetation.....	3
Changes in vegetation.....	3
Fauna.....	4
Waterholes.....	5
Socio-demographic and economic profile.....	6
Objectives.....	6
Methods.....	7
Advances.....	7
Annexes.....	10

Introduction

Due to the karstic nature of Yucatan's peninsula, the soil gets saturated with water during rain season forming water holes or "aguadas" in the lower regions. During dry season these water holes are the main source of water to fauna (Aranda, 1990, Arana, 1994, Hernández-Betancourt, 1996, Hernández-Huerta et al 2000, Naranjo, 2001; García_Gil 2003). Permanent water holes tend to be located in bigger numbers surrounding settlements (*ejidos*) (S. Calmé, pers. com). As a result, individuals of species such as Tapir, White-lipped Peccary and Jaguar, must go outside the limits of the reserve to get water (March 1990, Herndez-Huerta et al 2000, Herrera 2001, Escalona-Segur et al 2002, García – Escala 2003, García-Gil 2003, Martínez-Kú 2007). There are some studies on the relation between water holes and fauna (Darío, 2002; García-Escalona, 2003; Mandujano and Gallina, 1995; Sánchez and Valadez, 1989 y Vaughan y Weiss, 1999, Martínez-Kú 2007). Martínez_Kú (2007) data sustains that areas with water holes have more diversity of mid-size mammals during dry season while there is no significant difference during rainy season. He also reports that human activities in the water hole area can have an impact on the habitat. However, more information is necessary to understand how this works.

When planning the reserve's boundaries, the location of villages and land use by local inhabitants were not taken into account, in particular because the region was barely being settled at the time the reserve was decreed (1989). Since then, the population grew from 3,000 to more than 25,000 people. The location of areas of special importance for biodiversity conservation was not considered either. The poor design of the core areas (Galindo 1999) has resulted in the southern core area being located adjacent to several villages without any buffer zone in between and as a consequence, it is very vulnerable to slash and burn agriculture, as well as poaching and wildlife trafficking.

Forest cover declined in Calakmul region from 1974 to 2000 both within and outside the reserve, with a peak in forest loss in the total interior and the external buffer from 1986 to 1990, improving considerably from 1990- 2000. The net change in forest cover from 1974-2000 was -0.70 in the external buffer and -0.34 within the reserve. (Rayn-Villalba D. 2006. Factors affecting the efficacy of selected protected areas of central and southern Mexico. PhD Thesis, School of Biological Sciences, University of East Anglia, UK).

Study site

Calakmul is part of the second largest area of tropical forests in North America, the Maya Forest. The study area is located in the 19° 12' 00" and 17° 48' 39" N and 90 29' and 89° 09' 39" W, southeast of the state of Campeche bordered to the north by Hopelchén municipality, to the west by Escárcega and Candelaria municipalities, to the south by Guatemala and Belice, and to the east by the state of Quintana Roo. The altitude range is 260 to 360 above sea level. According to Köppen, modified by García (1973), the climate is warm sub-humid (Aw), with the mean annual temperature of 27⁰ C and a low of 18⁰ C. The average annual rainfall in the area is 750 mm (Arriaga et al. 2000). Calakmul

municipality extension is 13,839.11 Km² representing 24.34% of Campeche State (Gobierno de estado de Campeche, 2000).

Vegetation

According to Martínez and Galindo (2002) the ecosystems present in Calakmul include:

- Subtropical and subtropical dry broadleaf forest
- Tropical and subtropical grasslands, savannas, and shrublands
- Flooded grasslands and savannas
- Wetlands
- Riparian vegetation
- Secondary vegetation

Change in vegetation in Calakmul Biosphere Reserve

In Rayn-Villalba D. (2006. Factors affecting the efficacy of selected protected areas of central and southern Mexico. PhD Thesis, School of Biological Sciences, University of East Anglia, UK) it was found that although the loss of vegetation cover slowed down after the reserve was decreed in 1989, the poor reserve design has facilitated significant impacts on flora and fauna, including the increase in deforestation in core areas. This was exacerbated by the lack of clear definition of the uses of each part of the reserve.

Net change in forest cover (%)			
Period	External buffer	Total interior	Core areas
1974-1986	-0.74	-0.34	-0.28
1986-1990	-2.41	-2.37	-2.29
1990-2000	0.02	0.34	0.46
1974-2000	-0.70	-0.34	-0.31

It was also found that the loss in forest cover was lower in the centre of the reserve regardless of whether it was part of a core area or not. Population and road density by 2000 were also lower in the centre. This supported the idea that isolation from the edge provides protection.

Fauna

There are 75 species of reptiles and 18 species of amphibians in the reserve, which represents 70 percent of the amphibians found in the Yucatan Peninsula. Thirty-five of the species of reptiles and 5 species of amphibians are considered threatened, in danger, rare, or in need of special protection according to the Official Registry of Mexican Ecology. 31 species of fish have been identified, most prominent of which is the family Chichilidae, represented by eight species. Up to the year 2000, inventories of butterflies had documented 380 species, although the total number is estimated at 500 (Pozo et al. 2001). Pozo, C., Galindo-Leal, C., Cedeño-Vázquez, J.R., Calderón, R., Tescum, UC., Tuz, N. y Maya Martínez. 2001. Inventario y monitoreo de anfibios, reptiles y mariposas de la Reserva de la Biosfera de Calakmul, Campeche. Fase II. Reporte final. ECOSUR, CONABIO. Q. Roo. 41 pp.

Herpetofauna

There are 18 amphibian species reported in Calakmul area (Pozo de la Tijera, 1988), which represents 75% of the species found in Yucatán Peninsula. All the species belong to the Order Anura, with 6 families represented; Bufonidae with 2 species, Rhinophrynidae with one, Hylidae with two, Leptodactylidae with two, Mycrohylidae with two, and Ranidae also with two.

There are 59 reptile species reported (Calderón, 1999) representing almost 32% of the 182 species in Yucatán Peninsula. Three Orders are represented; Crocodylia with one species (*Crocodylus moreletii*) from the Crocodylidae family; Testudines, with five species from the Bataguridae, Kinosternidae and Emydidae families, and Squamata with two Suborders Sauria and Serpentes and 13 families.

Thirty-five of the species of reptiles and 5 species of amphibians are considered threatened, in danger, rare, or in need of special protection according to the NOM-ECOL-059-2001

Ornitofauna

More than 350 avian species have been identified in Calakmul region, representing 62 families, 53% are whole year residents, 18% winter residents, 2% summer residents, 6% transient, 2% altitudinal migrants, and 15% vagrants (Berlanga et al 2000; SEMARNAT, 1999). Approximately one third of them are common to the Neotropical forests of Central and South America; 9 species are endemic for Mesoamérica, 32 are threatened, including the king vulture (*Sarcoramphus papa*), the hawk eagle (*Spizaetus tyrannus*), the ocellated turkey (*Agriocharis ocellata*), and the royal duck (*Cairina moschta*), the latter being in danger of extinction according to Nom-Ecol-59 (Instituto Nacional de Ecología 1999).

Mastofauna.

There are 94 species of wild mammals registered in Calakmul, with 26 families and 9 orders represented (Ceballos et al 2002, Cervantes et al, 1994; Semarnat, 1999, Ramírez et al, 1986). There are 47 species of Quiroptera, 15 species of Rodents and 16 species of Carnivore. Felids are among the most notable, with five of the six species in Mexico present in the reserve: the jaguar (*Panthera*

onca), puma (*Puma concolor*), ocelot (*Leopardus pardalis*), margay (*Leopardus wiedii*), and the jaguarondi (*Herpaelurus yagouaroundi*). Also found in the region are six of the eight marsupials of Mexico, *Marmosa canescens* and *Didelphis marsupialis* among them. Present as well in Calakmul are the howler monkey (*Alouatta pigra*) and the spider monkey (*Ateles geoffroyi*) in danger of extinction and found in the Yucatan Peninsula, Guatemala, and Belize. Other threatened species include the anteater (*Tamandua mexicana*), the white-lipped peccary (*Tajassu pecari*), and the tapir (*Tapirus bairdii*) (CONABIO 1998; Instituto Nacional de Ecología 1999 a). Also present are the Yucatán brown brocket deer (*Mazama pandora*), which is endemic to Mexico and the white-tailed deer (*Odocoileus virginianus*).

Water holes



The hydraulic system in Calakmul region has an important role in the distribution and dynamics of flora and fauna populations. Water quality is poor due to excess in calcium sulfates, so it is not drinkable for humans (Martínez-Kú 2007), so the main available source of drinking water is rain stored in water holes (García_Gil, 2003). These water holes are swamp like areas originated by erosion and sedimentation processes, together with a weather regime in which precipitation and evaporation are in equilibrium. Vegetation consists mainly in herbs and shrubs adapted to extreme conditions of flooding and drought, and keep humid conditions in dry months. In Calakmul due to meteorological factors, soil permeability and land use, many water holes dry up completely (García_Gil, 2003, Mutinda, 2002). García_Gil AÑO? registered 1,353 water holes in Calakmul Biosphere Reserve, of which 485 are in the south section of the reserve and 868 in the north. Puc Cabrera (2008) found that water holes are of great important for avian assembles, especially during dry season. They provide refuge, feeding and nesting sites; its depth is associated with avian species richness. Martínez_Kú (2007) data sustains that areas with water holes have more diversity of mid-size mammals during dry season.

However, water holes in the north section are smaller and shallower thus more prone to dry up. This implies that species move to the south during dry months. Moreover, permanent water holes tend to be located in bigger numbers surrounding settlements (*ejidos*) (S. Calmé, pers. com). As a result, individuals of species such as Tapir, White-lipped Peccary (Martínez-Kú 2007, Rafael Reyna, 2005) and Jaguar, must go outside the limits of the reserve to get water (March 1990, Hernandez-Huerta et al 2000, Herrera 2001, Escalona-Segura et al 2002, García –Escala 2003, García-Gil 2003).

Socio-demographic and economic profile

There are 84 *ejidos* (communal land) with an estimate population of 25 thousand inhabitants in Calakmul municipality; 30 of these *ejidos* are adjacent to Calakmul Biosphere Reserve. Communities are rural, Xpujil being the largest settlement with a population of 1,213 inhabitants. There are approximately 3,000 inhabitants living inside the polygon (PACO PERS COMM). The main human activities are agriculture and cattle (87%), with only 13% of the activities related to tourism, transport, commerce and construction, INEGI 2000?

The main access is the federal highway No. 186 from Escárcega to Chetumal (west-east); which divides the northern core area and the buffer area. There is another road from Hopelchén (north-south) to Xpujil. This road cuts through the southern core area, and there are other minor roads to Zoh Laguna and the archeological site within Calakmul. Most *ejidos* are connected by smaller paved and unpaved roads INEGI 2000?

Infrastructure and services in Calakmul are inadequate. A very small percentage of *ejidos* has electricity; the water is scarce in the region and during dry season (November-June) the situation is critical. Some communities do not have water holes and they have to bring the water from Laguna de Alvarado to the southeast of the municipality (Steadman 1997, Morales y Magaña 2001).

Current threats:

- Forest fires
- Population growth
- Conflict between the reserve and the population
- Illegal hunting
- Agriculture (slash and burn) and cattle
- Highways and roads
- Tourist infrastructure
- Faulty design of the polygon
- Lack of synergy and coordination between institutions and civil associations

Objectives

- To assess ecosystem integrity in relation to water availability in Calakmul Biosphere Reserve and adjacent *ejidos*.
- To create alternative proposals for water management in Calakmul region, with emphasis on community participation (i.e. voluntary reserves within adjacent *ejidos*)

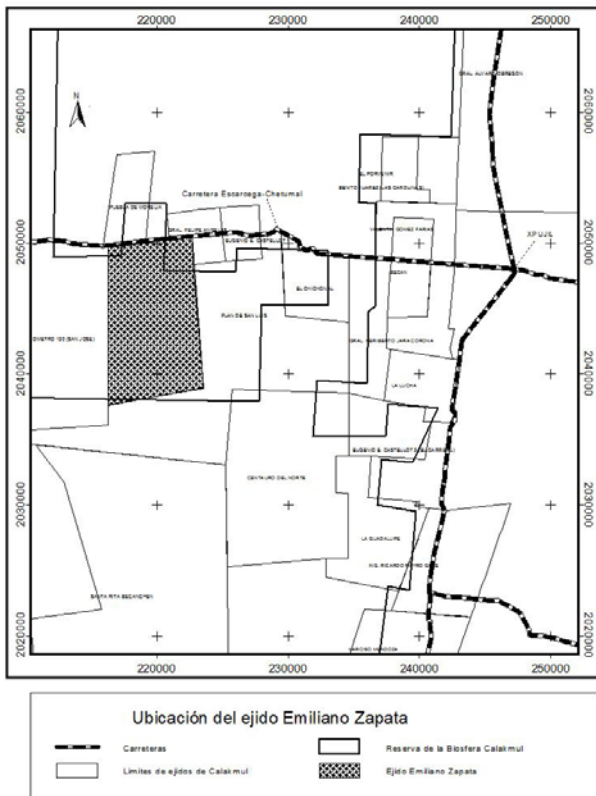
Methods

- Data already available will be collected from NGO's, governmental and academic institutions in order to be integrated and analyzed to create alternatives for the management of water supply in Calakmul Biosphere Reserve.
- Monitoring of selected water holes within and adjacent to Calakmul Biosphere Reserve.
- Visits to adjacent *ejidos* to interview local people will allow us to explore the possibility of community participation in proposals such as voluntary reserves. Interviews will be based on a questionnaire. Unless requested otherwise, all interviews will be tape-recorded.

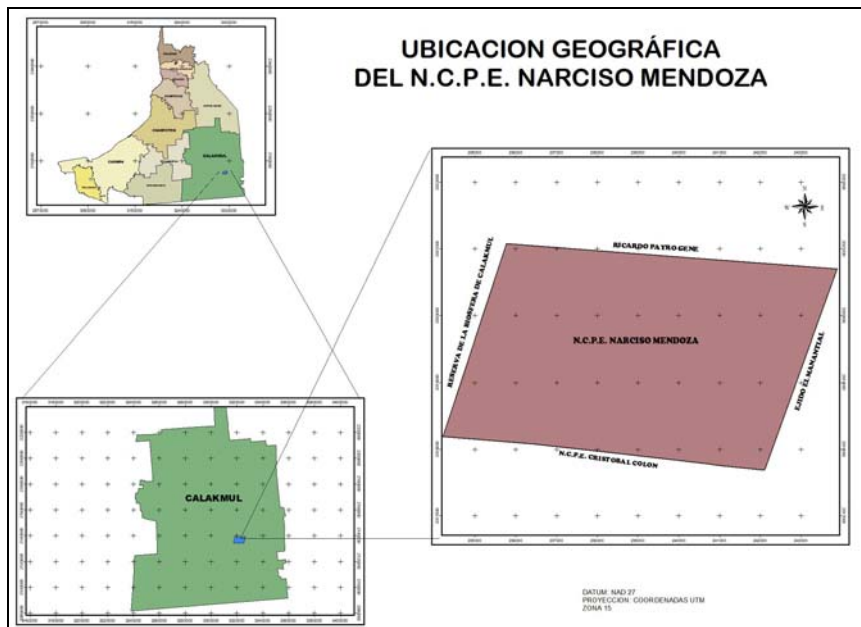
Advances

- Collection of data from ECOSUR and Calakmul Biosphere Reserve (April-june)
- Field trips to Calakmul Biosphere Reserve to choose permanent water holes to monitor (July-August). Local people is monitoring the water holes in the *ejidos* and staff from the reserve is monitoring the water holes within the polygon.
Water hole No.1 El Ramonal area: 25m X 35m, 1.6 deep
Water hole No.2 (without name) 500 mts away from El Ramonal 2 area: 30 x 40 m.
Water hole 3 El Teniente. Data not yet available
- Visit *ejidos* adjacent to the reserve with permanent water holes to explore the possibility of community participation (September-November).

Ejido 1. Emiliano Zapata is partially located within the buffer zone of Calakmul Biosphere Reserve with 7650.00 ha. Vegetation is in good condition and local people respect the regulations. The main productive activities are cynegetic services (legal hunting), Chilli production, honey production, cattle in small proportions. People living in Emiliano Zapata are originally from several estates: Veracruz, Tabasco, Chiapas, Michoacán, Yucatán and Oaxaca.



Ejido 2.Narciso Mendoza is located in the kilometer 33 of the Xpujil to Justo Sierra Méndez road. Its south west border is adjacent to the reserve.



Ejido 3

Cristobal colon. Data not yet available

- Preparation of questionnaires for interviews (Annex 1, September-November)
- Integrating maps of Calakmul roads, communities, water holes, vegetation, etc. (Nov-April)

ANNEXES

Questionnaire

Semi-structured interview

Name of interviewer:

Place and date:

Name of interviewee:

Age:

Sex:

Where are you from? How long have you (or your ancestors) lived here?

Do you know the limits of Calakmul Biosphere Reserve?

How do people living within the region make use of the resources available?

How do people living outside the region make use of the resources available?

Do people use the timber? How and since when?

Do you use any other natural resource? How and since when?

What species of animals use to live in Calakmul?

When was the last time you or anyone else saw one?

Why do you think they disappeared?

What species of animals still live in Calakmul?

Have you seen them or any evidence of its presence (excreted burrows or footprints)?

What animals are used and what for? (Hunting, food, medicine, sale, other)

Do you know where the animals are usually found? Do you know the places where there is more abundance? (in the map)

Where do you and other people living in Calakmul get water?

Can you get water all year long?

What do you use water for?

Do you know where the main stream, rivers, and waterholes in the region are?

Do you know the names? (MAPA)

Do you know if people from outside uses the water?

Do you know if the distribution of stream, rivers or water holes has change?

If it has, why do you think it happened?

When is the rainy season? Has it changed? How and since when?

Why do you think it has changed?

Are there any places where the soil is washed down when it rains?

Where? (Map)

Do you remember if any of these events has affected the region in the last 10 years?

Draughts

Floodings

Mudslide

Hurricanes

Has the climate changed in any way? How and since when?

Why do you think it has changed?

References

- Aranda M., 1990. El Jaguar (*Panthera onca*) en la Reserva de la Biosfera de Calakmul, México: morfometría, hábitos alimentarios y densidad de población. Tesis de Maestría. Sistema de estudios de posgrado. Programa regional en Manejo de Vida Silvestre para mesoamérica y el Caribe. Universidad Nacional de Costa Rica. 93 pp.
- Arriaga, L. M., J. M. Espinoza, C. Aguilar, E. Martínez, L. Gómez, and E. Loa. 2000. Regiones terrestres prioritarias de México. CONABIO.
- Berlanga_Cano, M y P. Word, J. Salgado y E. Figueroa 2000. AICA171. Áreas de importancia para la conservación de las aves en México. Arizmendi, M. y L. Márquez coordinadores CONABIO, México.
- Calderón, R. 1999. Los reptiles de la Reserva de Calakmul, Campeche, México. Tesis de Licenciatura. Universidad Michoacana de San Nicolás de Hidalgo.
- Calmé S. pers. Com 2008
- Ceballos G., C. Chávez, A. Rivera, C. Manterola y B. Wall. 2002. Tamaño poblacional y conservación del jaguar en la Reserva de la Biosfera de Calakmul. En: R. Medellín, C. Equihua, C. Chetkiewies, P. Crawshaw, A. Rabinowitz, K. Redford, J. Robinson y A. Taber, (eds.). El Jaguar en el Nuevo milenio. Primera edición. Fondo de Cultura Económica, México, D.F., p.p.403-417
- Cervantes F., A. Castro-Campillo, y J. Ramírez-Pulido, 1994. Mamíferos terrestres nativos de México. Serie Zoológica. 65:177-290.
- CONABIO. 1998. Estudio de País. CONABIO, Mexico.
- Escalona-Segura, G. J., Vargas-Contreras y L. Interián-Sosa. 2002. Registros importantes en mamíferos para Campeche, México. Revista Mexicana de Mastozoología. 6:99-103.
- Galindo-Leal, C. 1999. La gran Región de Calakmul, Campeche: Prioridades biológicas de conservación y propuesta de modificación de la Reserva de la Biosfera. Reporte final a World Wildlife Fund-México, D.F. 40 pp.
- García, E. 1973. Modificación al sistema de clasificación de Copen (para adaptarlo a las condiciones de la República Mexicana). Instituto de Geografía. Universidad Nacional Autónoma de México.
- García-Escalona, M. S. Calmé, B. Millar y E. Escobedo-Barrera, 2003. Murciélagos asociados a aguadas en la región de Calakmul, Campeche, México. En: Boletín Oficial de la Sociedad Mesoamericana para la Biología y la Conservación (eds). VII Congreso Mesoamericano para la Biología y la Conservación. Centro de Convenciones de Tuxtla Gutiérrez, Chiapas, México.
- García-Gil, G. 2003. Colonización humana reciente y formación del paisaje agrario en la Reserva de la Biosfera de Calakmul, Campeche, México. Tesis de doctorado. Facultad de Filosofía y Letras. Universidad Autónoma de México.
- Gobierno de estado de Campeche, 2000. Enciclopedia de los municipios de México. Campeche, Calakul. Centro Nacional de Desarrollo Municipal. <http://www.e-local.gob.mx/enciclo/campeche/>
- Hernández-Huerta A, V. Sosa, M. Aranda y J. Bello 2000. Records of small mammals in the Calakmul Biosphere Reserve, Yucatán Peninsula. The Southwestern Naturalist. 45:340-344.

- Instituto Nacional de Estadística Geografía e Informática, I. 2002. "Localidades de la República Mexicana, 2000". Obtenido de Principales Resultados por Localidad. XII Censo de Población y Vivienda 2000. In: C. N. p. e. C. y. U. d. I. B. (CONABIO). Editor.
- March 1994. Situación actual del tapir en México. Serie Monográfica 1. Centro de Investigaciones Ecológicas del Sureste (CIES). San Cristóbal de las Casas, Chiapas, México.
- Martínez, E. y C. Galindo (2002). La vegetación de Calakmul, Campeche, México: Clasificación, descripción y distribución. Boletín de la Sociedad Botánica de México. 71:7-32
- Martínez-Kú 2007. Importancia de las aguadas para los mamíferos de talla mediana y grande en Calakmul, Campeche, México. Tesis de licenciatura. Facultad de Ciencias Químico Biológicas. Universidad Autónoma de Campeche, Campeche, México.
- Mandujano and Gallina, 1995. Disponibilidad de agua para el veado cola blanca en un bosque tropical caducifolio de México. Vida Silvestre Neotropical. 4:107-118.
- Medellín G. y Ceballos. Avances en el estudio de los mamíferos de México. Asociación mexicana de mastozoología A.C. México D.F. 464 pp
- Morales, J. y R. Magaña 2001. Fuentes de impacto, necesidades de investigación científica y monitoreo en Calakmul, Campeche. Probaturo Península de Yucatán, A.C. The Nature Conservancy. 72 pp
- Naranjo, E. 2001. El Tapir en México. Biodiversitas 36:1-3.
- Norma oficial mexicana NOM-059-ECOL-2001. Protección ambiental- Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Publicada en el Diario Oficial el 06 Marzo del 2002
- Pérez Espinoza F. pers. Com 2009
- Pozo, C., Galindo-Leal, C., Cedeño-Vázquez, J.R., Calderón, R., Tescum, UC., Tuz, N. y Maya Martínez. 2001. Inventario y monitoreo de anfibios, reptiles y mariposas de la Reserva de la Biosfera de Calakmul, Campeche. Fase II. Reporte final. ECOSUR, CONABIO. Q. Roo. 41 pp.
- Pozo de la Tijera, C. , C. Galindo-Leal, R. Cedeño Vásquez, y R. Calderón. 1998. Herpetofauna de la Reserva de Biosfera de Calakmul, Campeche. ECOSUR-PPY. México. 17 pp.
- Ramírez Pulido, J., M. Claire, A. Perdomo y A. Castro. 1986. Guía de los mamíferos de México. Universidad Autónoma de México. México. 720 pp.
- Rayn-Villalba D. 2006. Factors affecting the efficacy of selected protected areas of central and southern Mexico. PhD Thesis, School of Biological Sciences, University of East Anglia, UK.
- Reyna-Hurtado Rafael and G.W. Tanner. 2005. Habitat Preferences of Ungulates in Hunted and Nonhunted Areas in the Calakmul Forest, Campeche, Mexico. Biotropica 37:4 676-685.
- SEMARNAT, 1999 Programa de Manejo de la Reserva de la Biosfera de Calakmul, México. Instituto Nacional de Ecología-SEMARNAT.
- Steadman-Edwards, P. 2000. Mexico: Calakmul Reserve. in A. P. Wood, P. Steadman-Edwards, and J. Mang, editors. The Root Causes of Biodiversity loss. Earthscan/WWF, London
- SEYBA (Servicios y beneficios ambientales SC de RL) 2008. Estudio de Ordenamiento territorial. (CONAFOR)
- Vaughan, C. y K. Weiss. 1999. Neotropical dry forest wildlife waterhole use and management. Regional Wildlife Program. Universidad Nacional Heredia, Costa Rica.