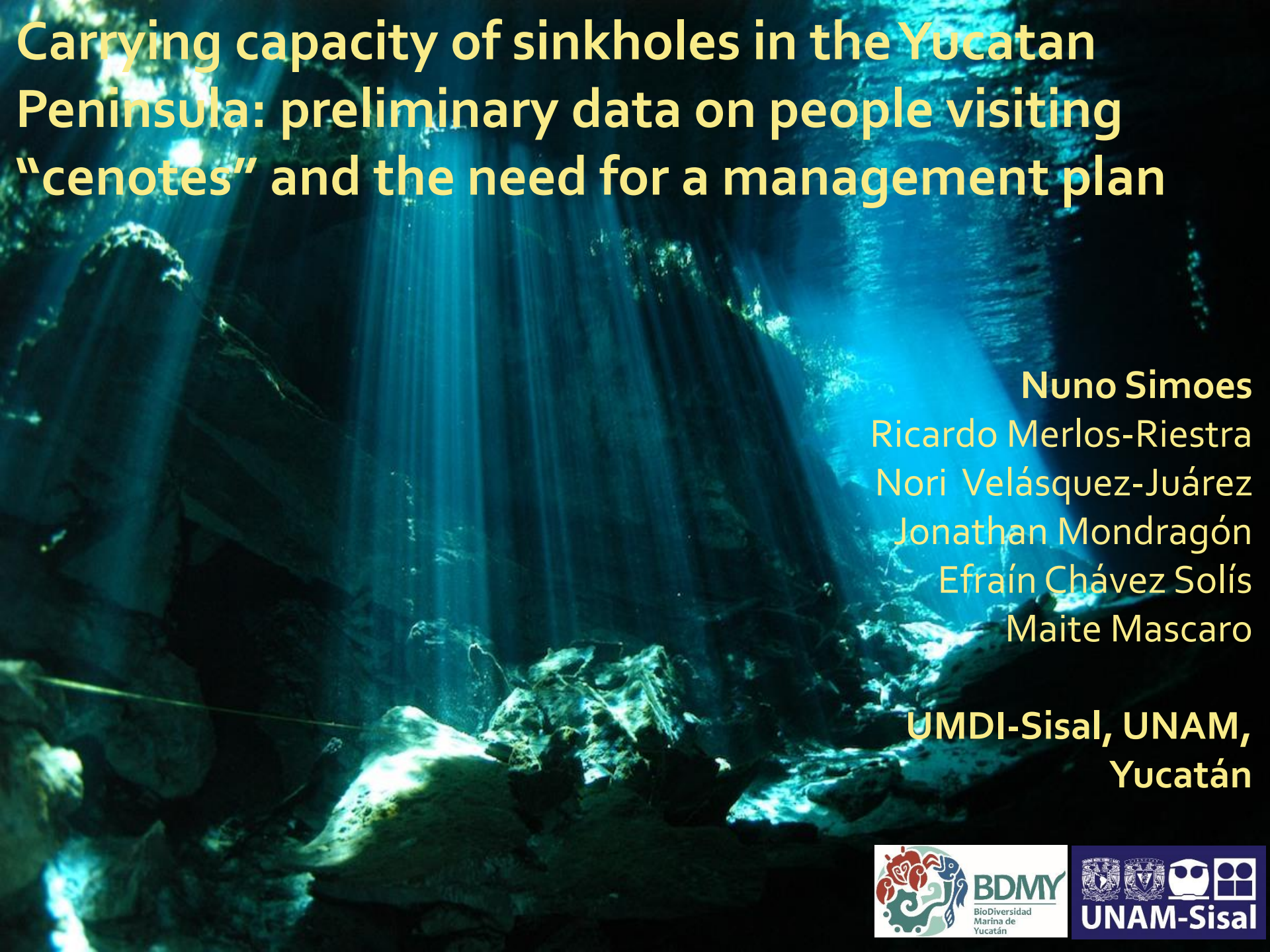
Carrying capacity of sinkholes in the Yucatan Peninsula: preliminary data on people visiting "cenotes" and the need for a management plan



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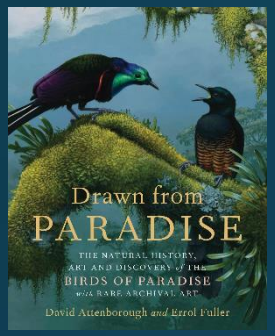
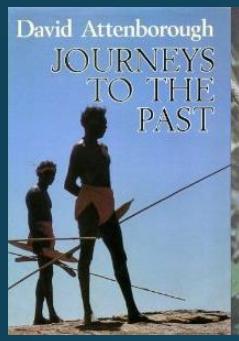
Brief historical background

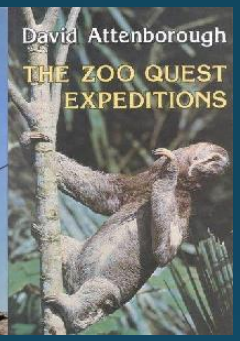
- World population growth
- Increased potential for mobility
- More time for recreational activities
- Development of the tourism industry
- Increased intensity of natural resource use
- Need to develop regulatory measures
- Need for baseline data to inform management decisions

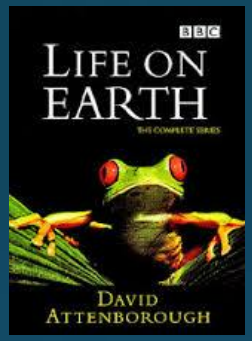
"Anyone who believes in indefinite growth on a physic finite planet is either mad or an economist"

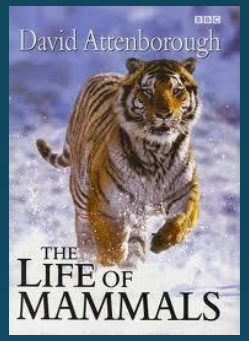
David Attenborough

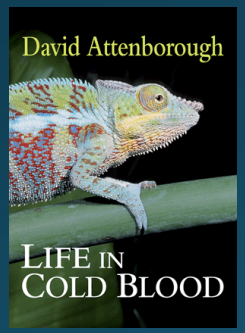


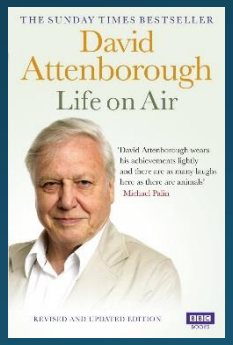


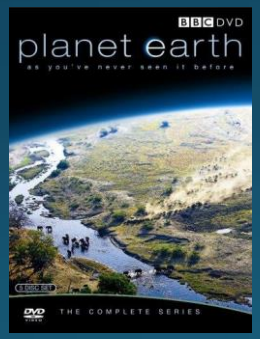


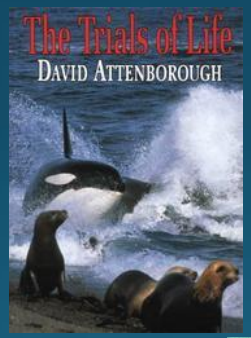


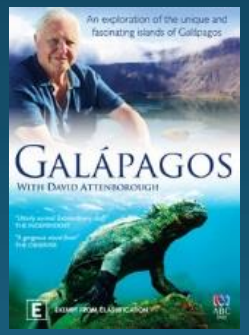


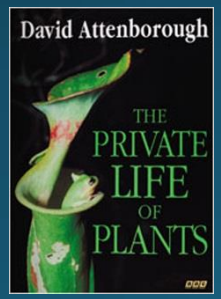


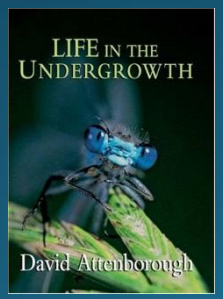


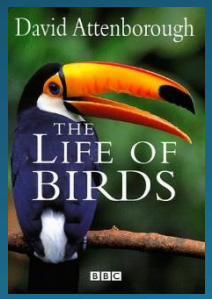


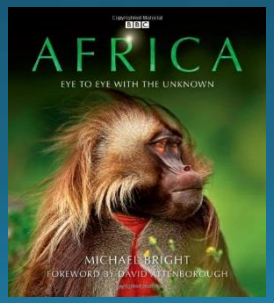


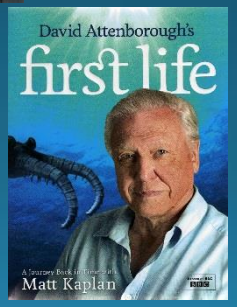












Regarding Yucatan "cenotes"

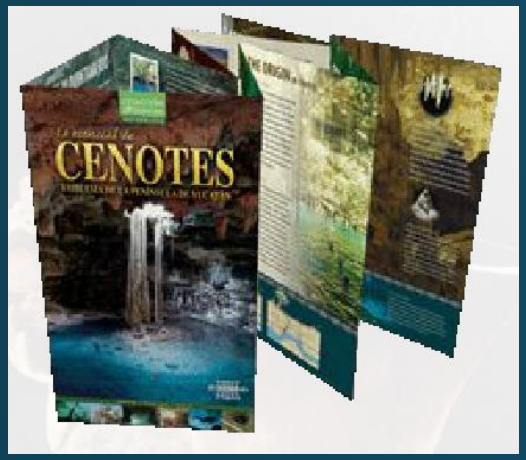
- "cenotes" have become a source of economic benefit for local populations
- They contribute to the preservation of the local forests and aquifers.
- Tourist development is recent (last 15 years)
- The number of "cenotes" with direct economic use has increased (30+ aprox)
- Number of visitors has increased (no official numbers)
- There are legal conflicts between municipalities
- Public health problems led to highly destructive and desperate government initiatives to control water quality, such as chlorination of water.

Regarding Yucatan "cenotes"

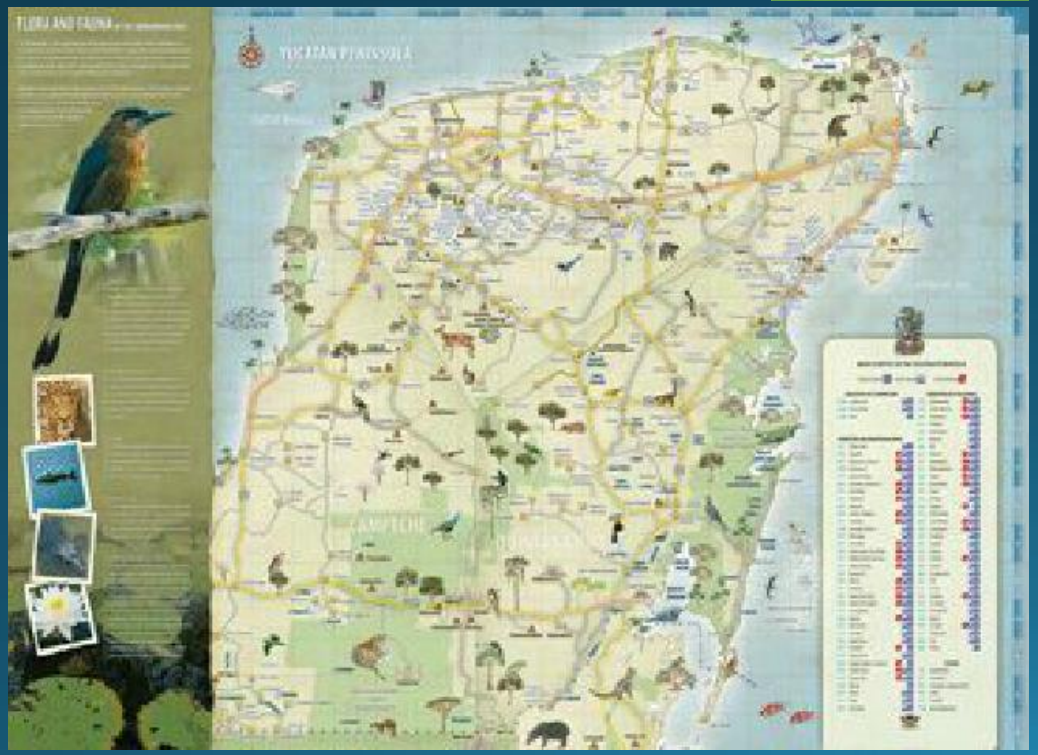
- Most visitors seek for leisure and recreation through swimming and diving activities.
- Such activities are controlled in only a reduced number of cenotes, but remain unmanaged in the rest
- Signs of impact such as organic and inorganic garbage accumulation, presence of specific chemicals
- These conditions impose important risks on stigobitic species in the flooded caves of Yucatan
- The resilience of cave fauna communities to disturbance is unknown.
- Urgent need for baseline metrics of cave fauna, water variables and user intensity, frequency and timing

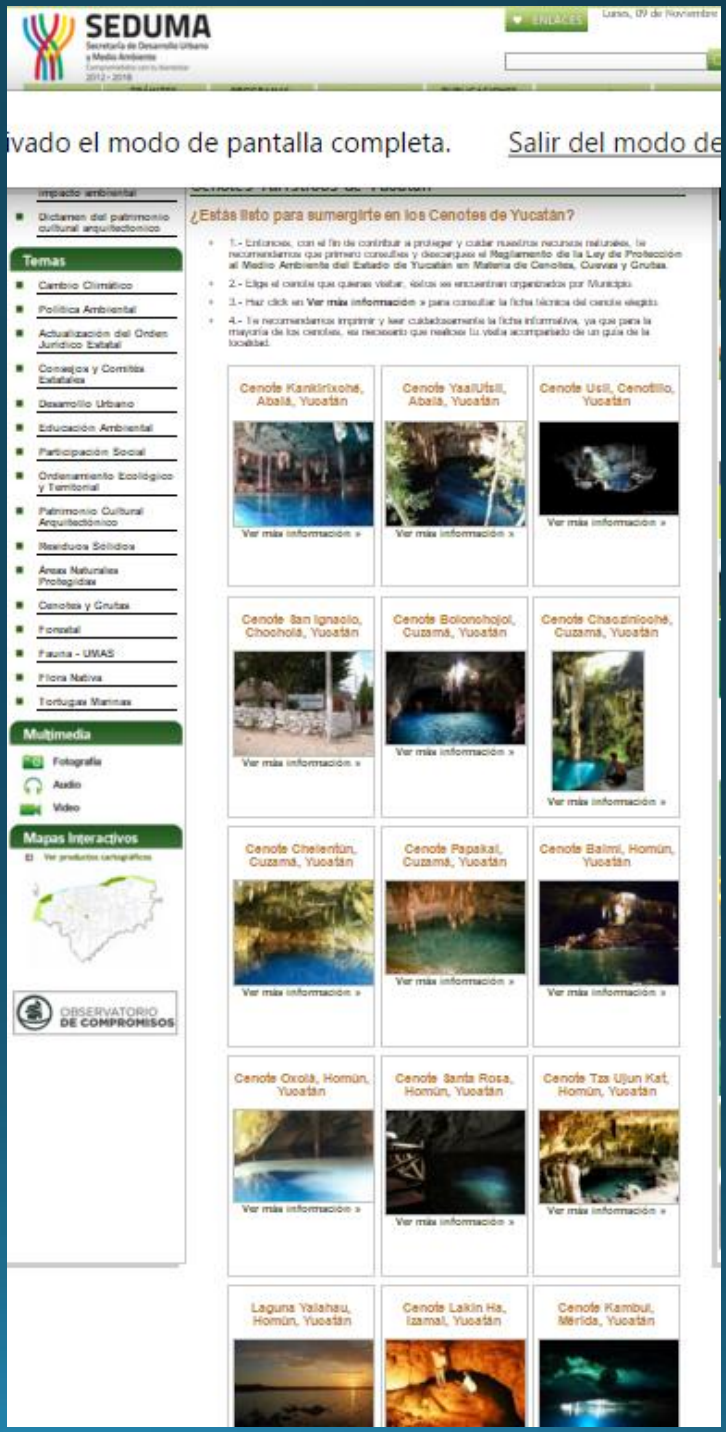
2241 identified cenotes and caves in Yucatán. There is a database of 32 cenotes available; 103 have been identified as potential tourist atractions (5%)

32 brief fact-sheets available through SEDUMA

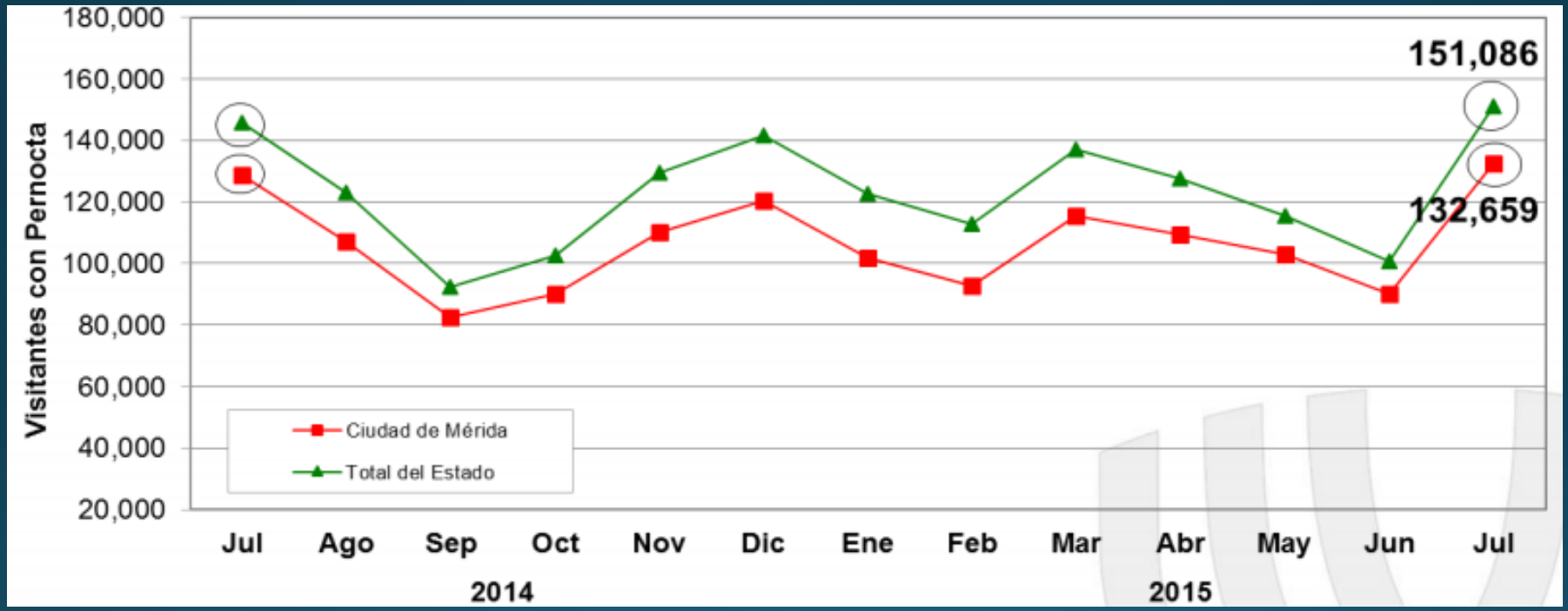


ESSENTIAL COLLECTION





Tourists that sleep in Merida



http://www.sefotur.yucatan.gob.mx/

What is the carrying capacity?

What are the most visited cenotes, and why?

How many people can be in a cenote at once?

What variables affect the value of the leisure experience?

How many km tourists are willing to drive to visit a cenote ?

What is the price that visitors are willing to pay to visit a cenote ?

Is there room for activity-specialization in each cenote ?

To apply existing methodologies to calculate carrying capacity we first need (for each cenote):

1. Distances and types of access roads
2. Parking area
3. Categorization access and flow in routes and stairs
4. Platform waiting area and Area water surface
5. Swimming area (water surface, 1.5m depth area)
6. Number of cars per day + number of visitors per car
7. Frequency, duration , types of uses, temporality
8. Origin of visitors
9. Cost per person
10. Infrastructure and Services offer
11. Experience and perception of satisfaction

And we need to describe the geology and ecology and each cenote:

1. Geology and edafology
2. Level of forest cover in the watershed
3. Matrix of species presence / absence
4. Abundance of conspicuous and detectable species
5. area rainwater basin and angle of watershed inclination
6. area and perimeter of the opening of the cenote
7. Amount of incident light reaching the water surface
8. Volume and depth of the cave
9. Distance to the nearest cenote
10. Number of cenotes within 1km
11. Distance to nearest town
12. Population of the nearest town

Three development axis

- spatially explicit cave fauna diversity/abundance and cave descriptors data base
- water level and temperature long-term monitoring
- user attendance metrics long-term monitoring

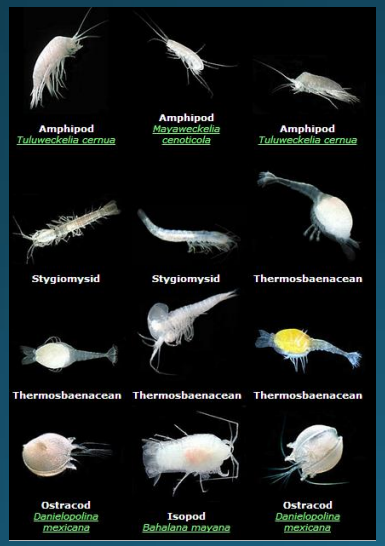
… and the biodiversity?

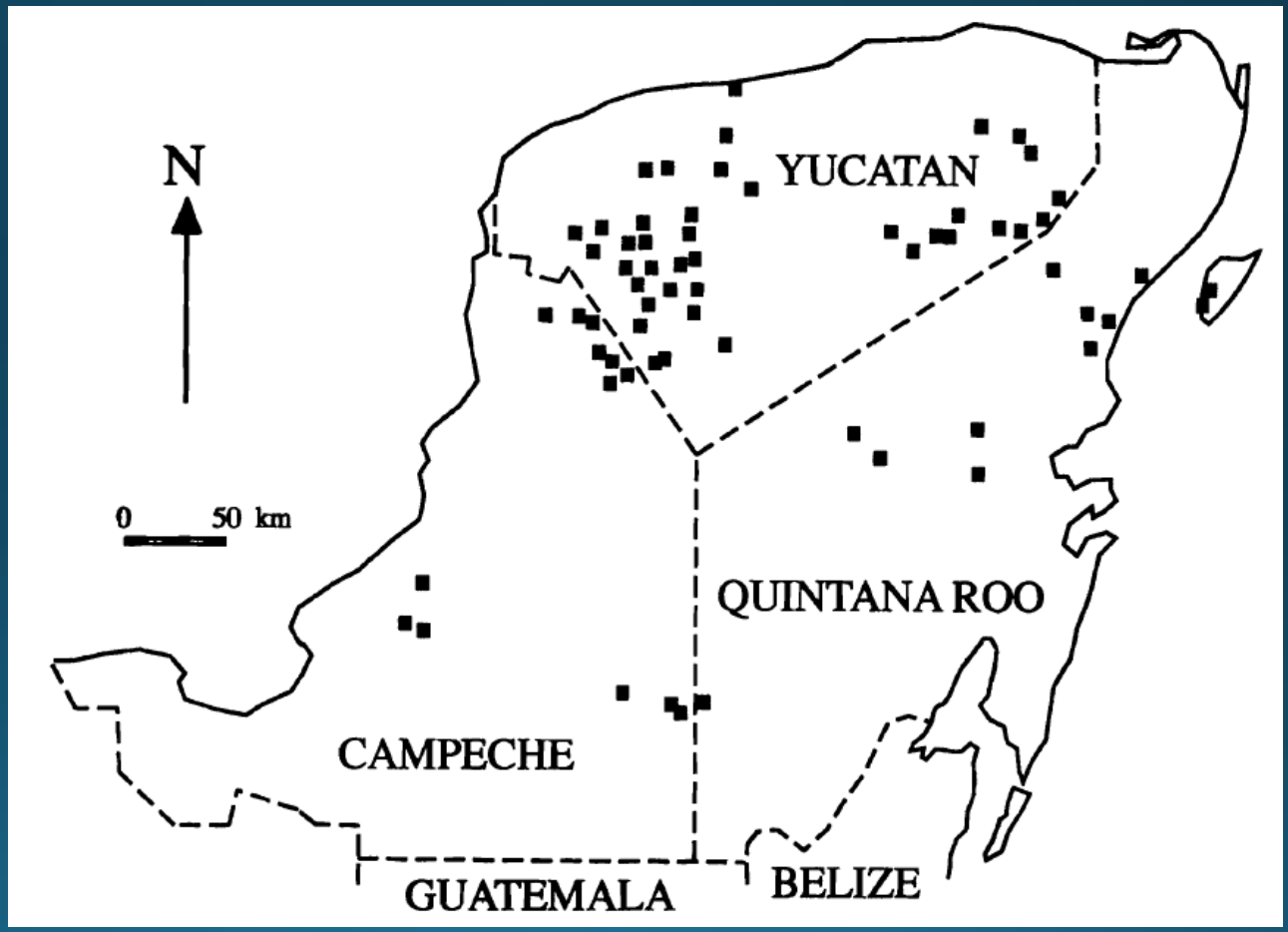
What do we know?

Fauna Troglobia Acuática de la Península de Yucatán

Thomas M. Iliffe
Dep. of Marine Biology, Texas A&M University at Galveston, Galveston, Texas 77553-1675 USA

1993
64 explored cenotes
22 estigobitic species
20 custaceans (7 orders)
2 fish (2 orders)





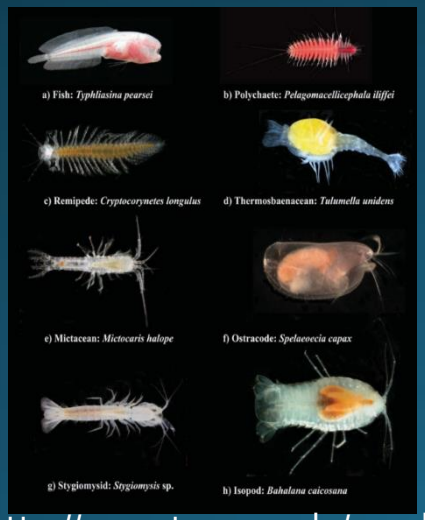
http://www.tamug.edu/cavebiology/

… and the biodiversity?

What do we know?

2010 – study population genetics of *Creaseria morleyi*

2014 (Yucatán peninsula)
http://www.tamug.edu/cavebiology/index2.html
Many more explored cenotes
41 estigobitic species
38 custaceans (2 clases, 7 orders, 17 famlies)
2 fish(2 orders)
1 polyquaete



The Linnean Society of London BIOLOGICAL Journal of the Linnean Society

Biological Journal of the Linnean Society, 2010, **99**, 315–325. With 3 figures

Genetic variation in the stygobitic shrimp *Creaseria morleyi* (Decapoda: Palaemonidae), evidence of bottlenecks and re-invasions in the Yucatan Peninsula

ALEJANDRO BOTELLO* and FERNANDO ALVAREZ

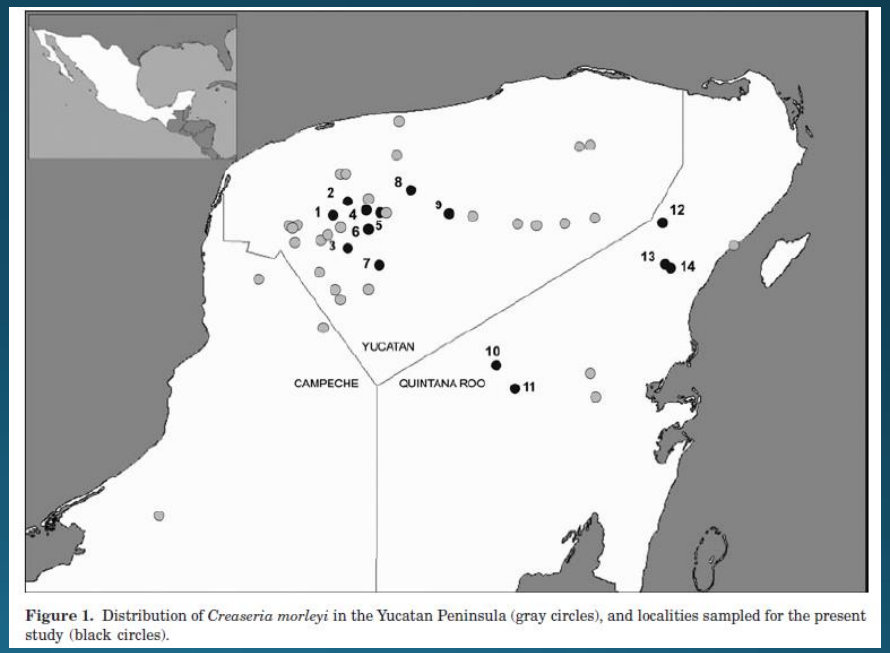


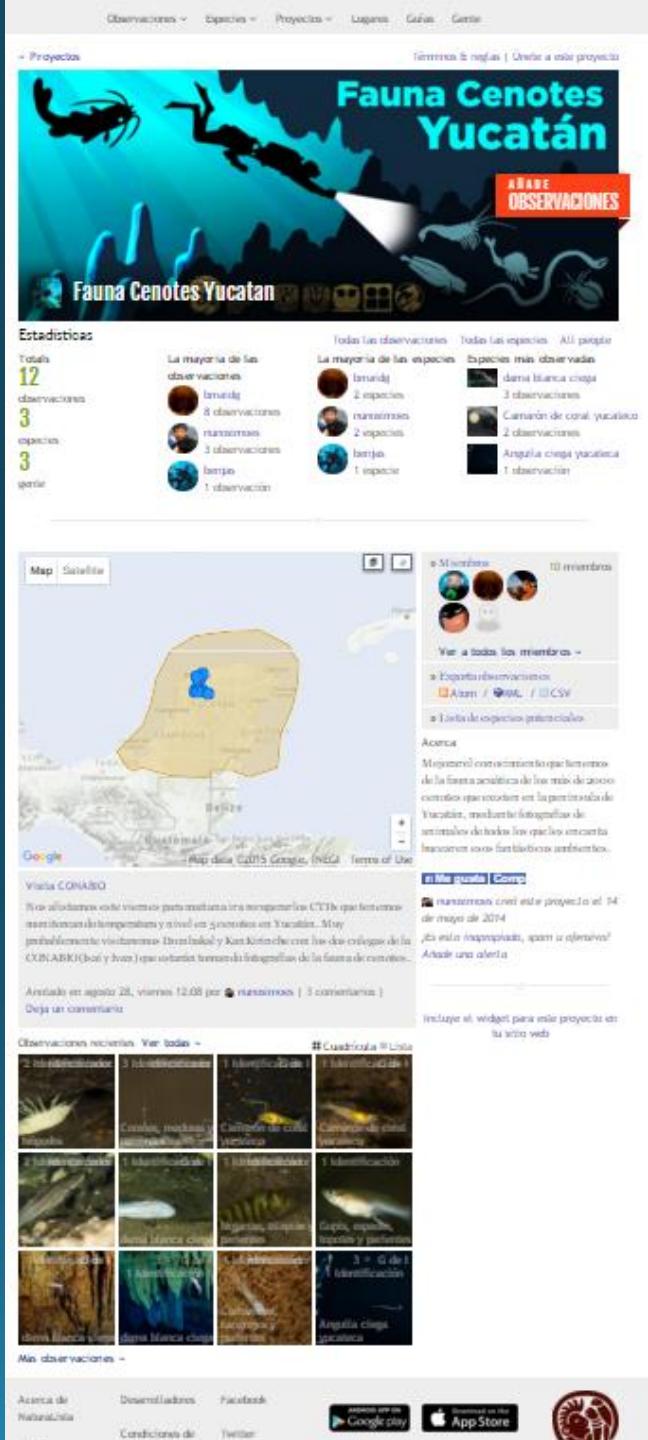
Figure 1. Distribution of *Creaseria morleyi* in the Yucatan Peninsula (gray circles), and localities sampled for the present study (black circles).

IUCN RED LIST Least concern

http://www.tamug.edu/cavebiology/

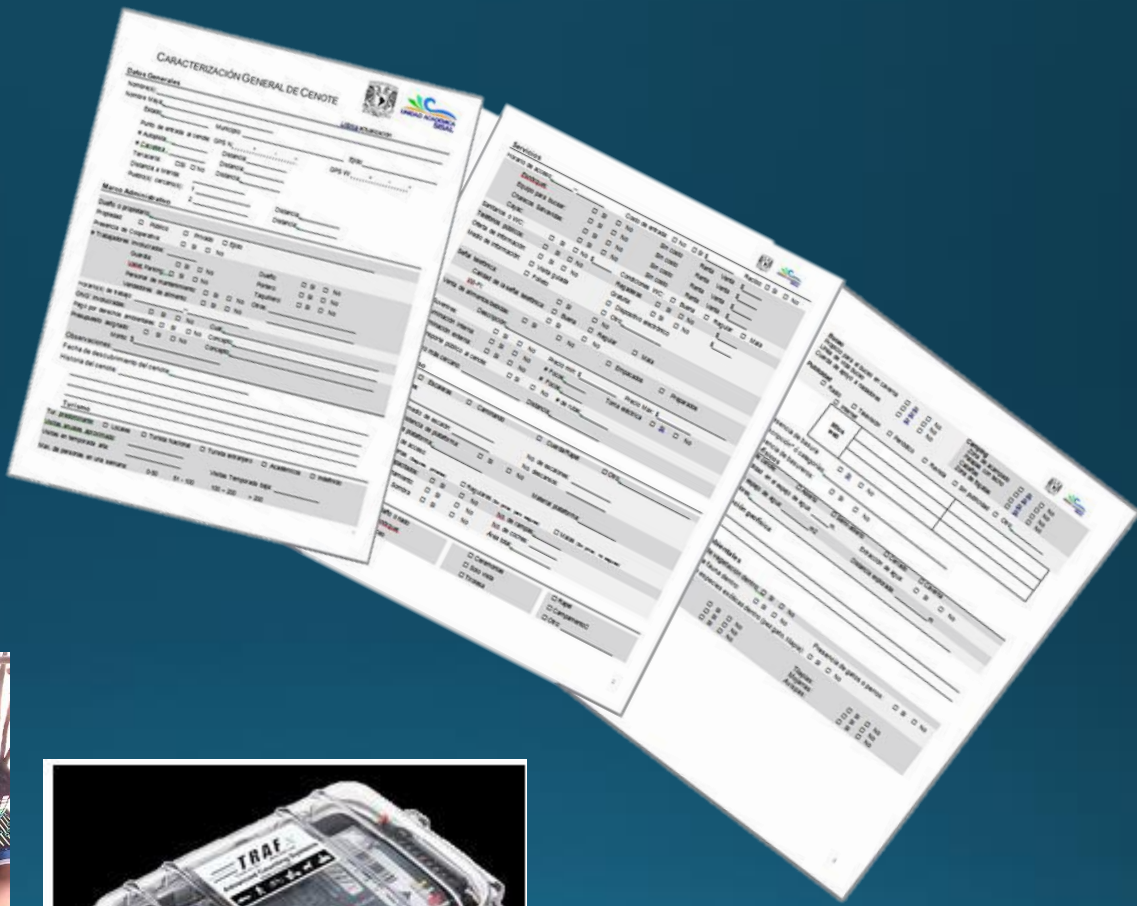
How to count Biodiversity?

There are many and varied cenotes. The cost of a unique and specific project to document the biodiversity is very expensive. An alternative relies on the contribution of users:



http://conabio.inaturalist.org/projects/fauna-cenotes-yucatan

Cenote descriptions and user attendance metrics monitoring




Ubicación de la cámara
fotográfica automática


Medicion en
campo

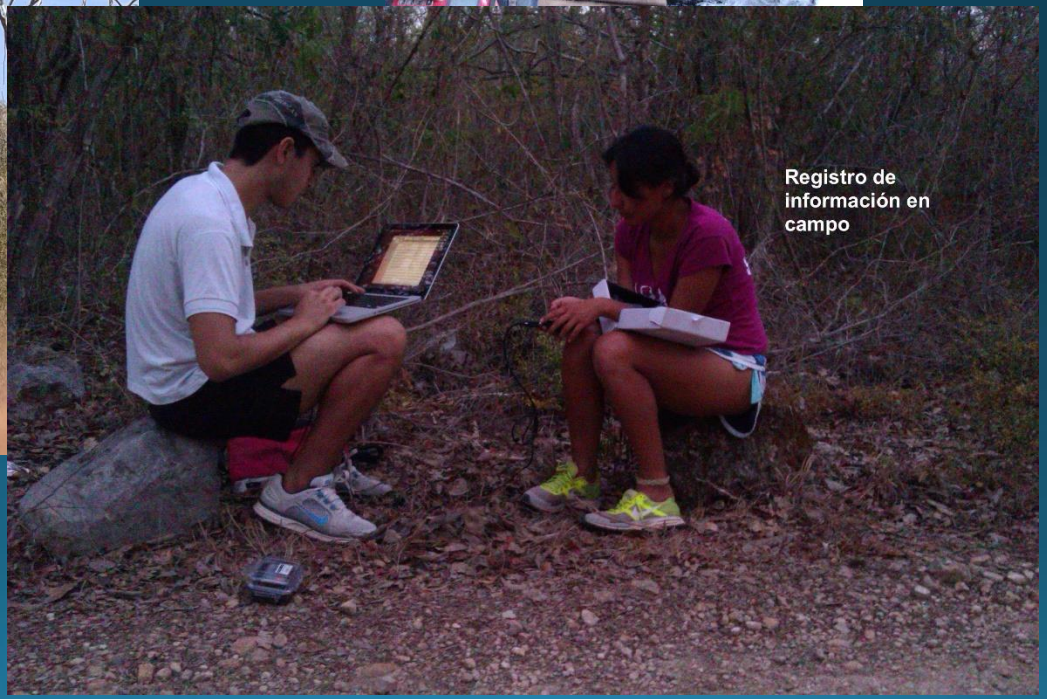

Registro de
información en
campo

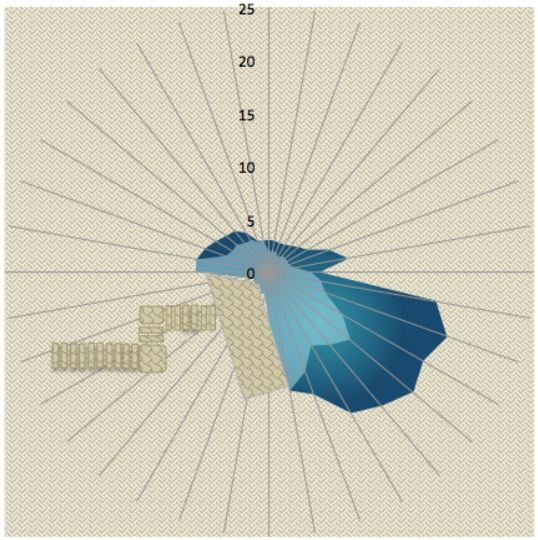
Chart Area

N

Área espejo de agua 204 m2
Dzonbakal

Cenote en caverna

- Profundidad > 1.5 m
- Zona con pie < 1.5 m
- Plataforma y escaleras

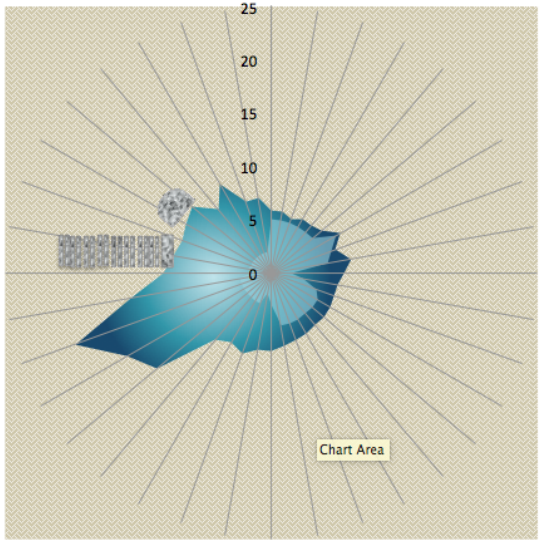


N

Área espejo de agua 231 m2
Sambulá

Cenote en caverna

- Profundidad > 1.5 m
- Zona con pie < 1.5 m
- Plataforma y escaleras

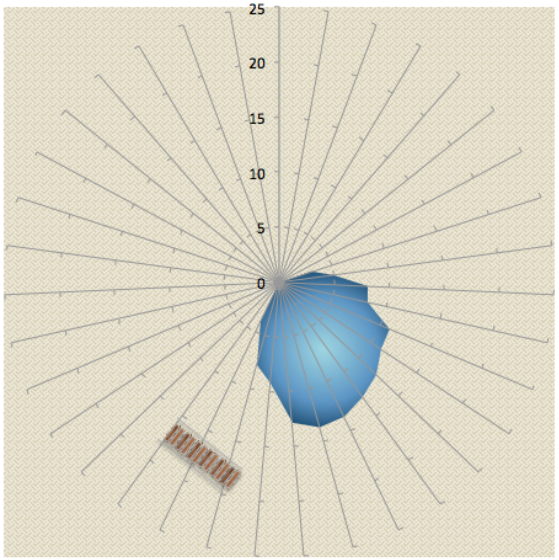


N

Área espejo de agua 120 m2
Yax'Há

Cenote en caverna

- Profundidad > 1.5 m
- Escaleras

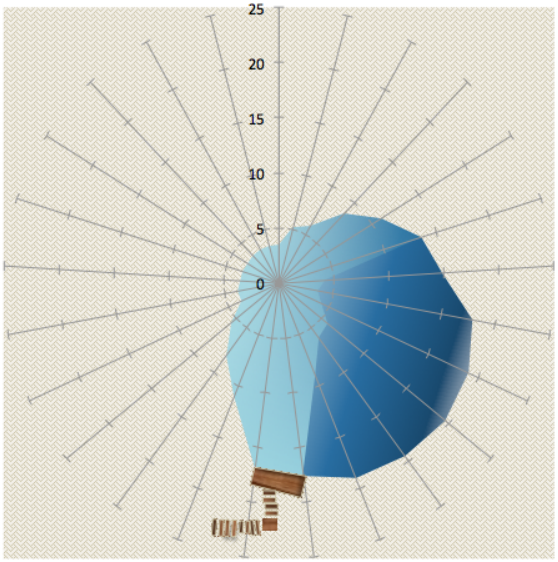


N

Área espejo de agua 432 m2
Kankirixché

Cenote de cántaro

- Profundidad > 1.5 m
- Zona con pie < 1.5 m
- Plataforma y escaleras



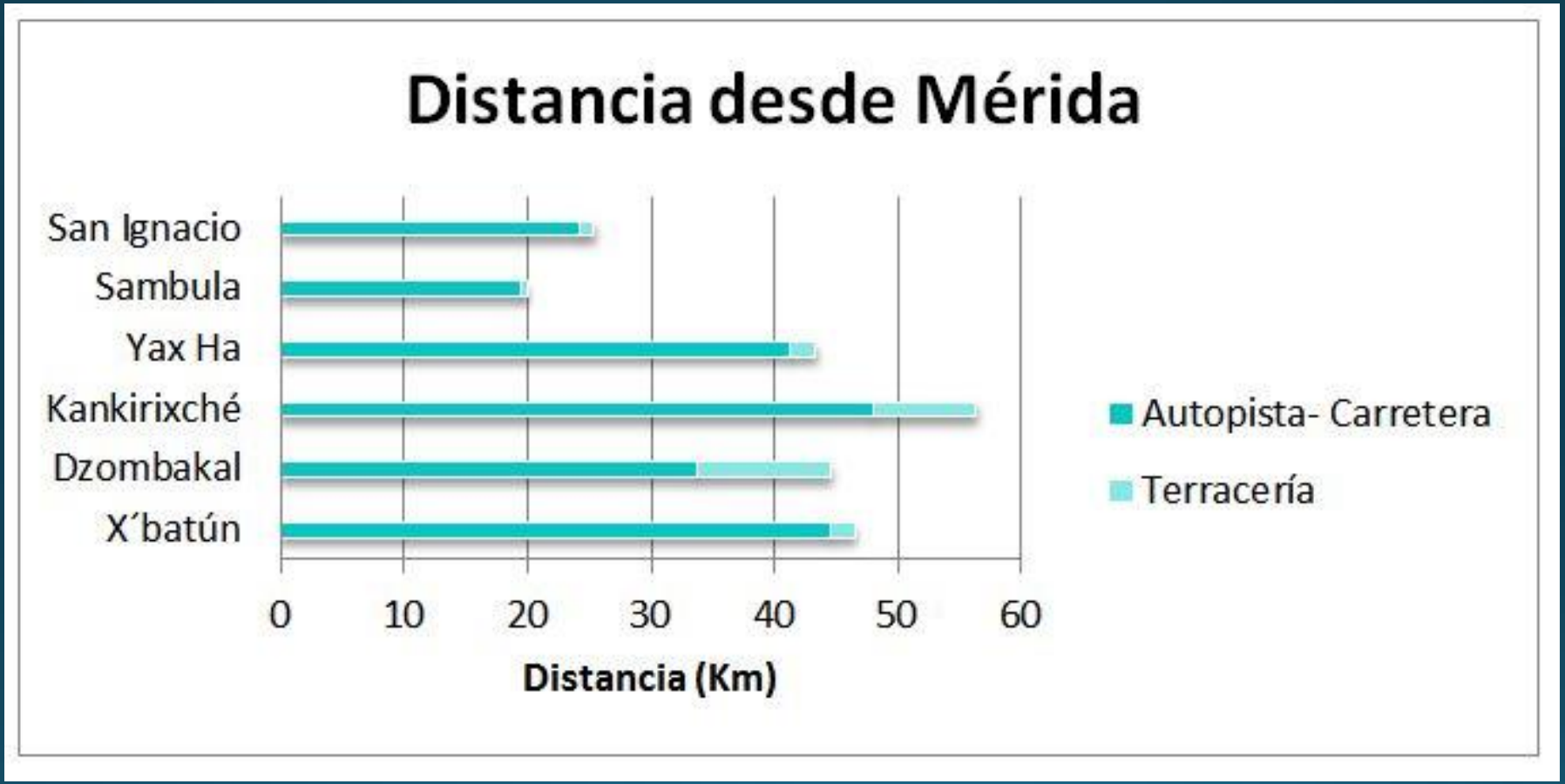




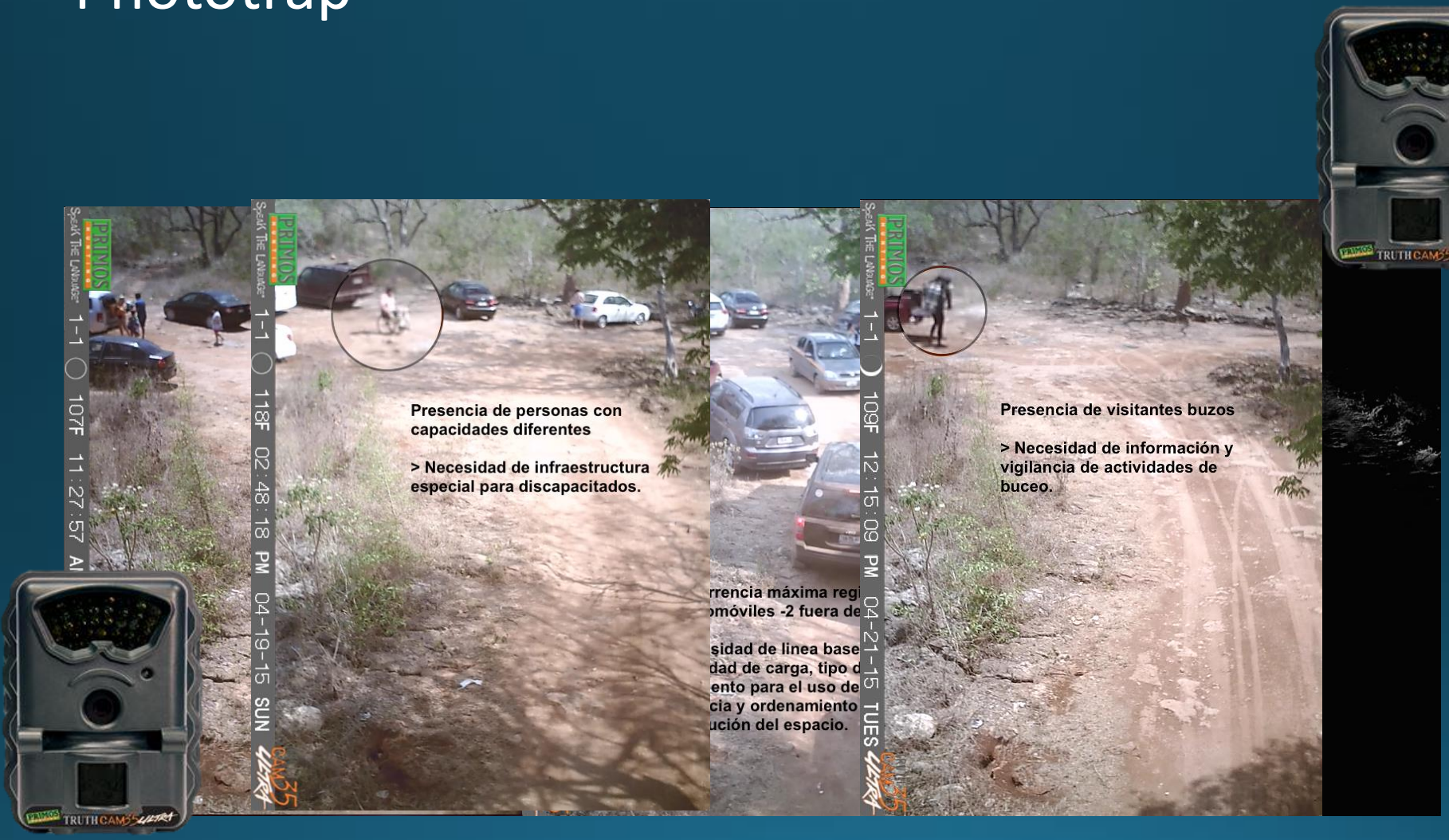




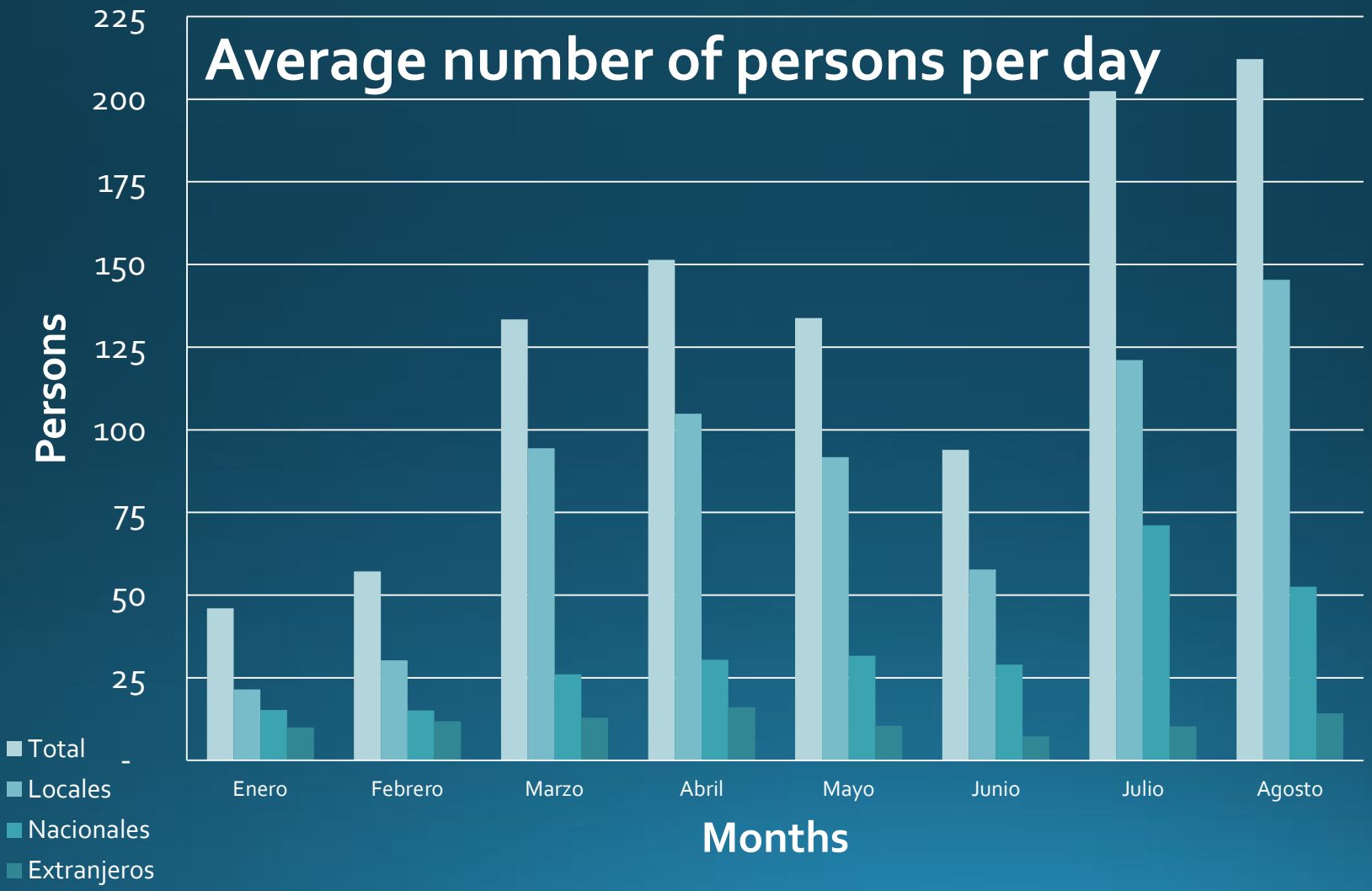
Distance To Merida



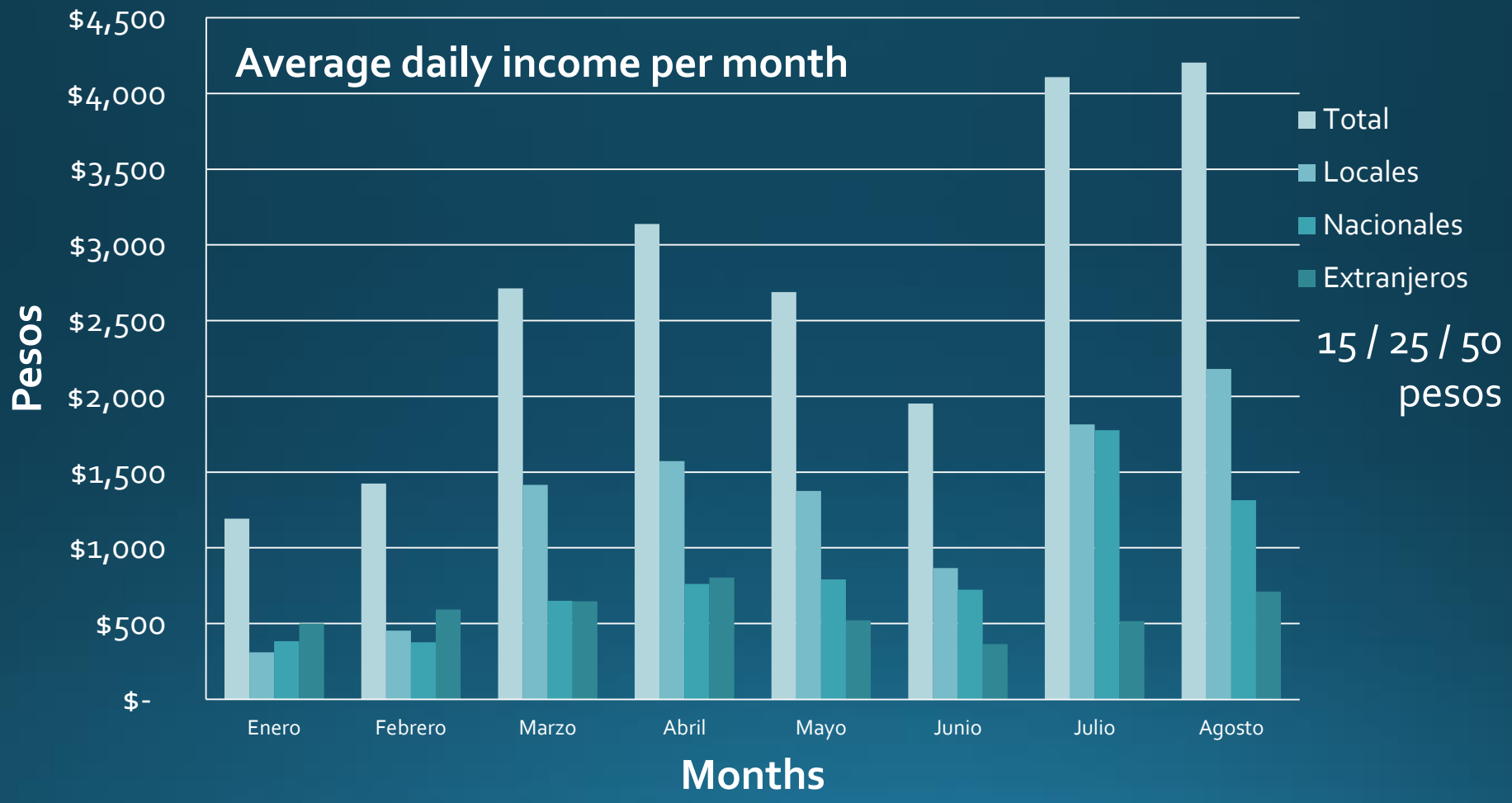
Phototrap


PRIMOS
Speak The Language
1-1 107F 11:27:57 AM
1-1 118F 02:48:18 PM 04-19-15 SUN
Presencia de personas con capacidades diferentes
> Necesidad de infraestructura especial para discapacitados.
1-1 109F 12:15:09 PM 04-21-15 TUES
Presencia de visitantes buzos
> Necesidad de información y vigilancia de actividades de buceo.
TRUTH CAM35 ULTRA

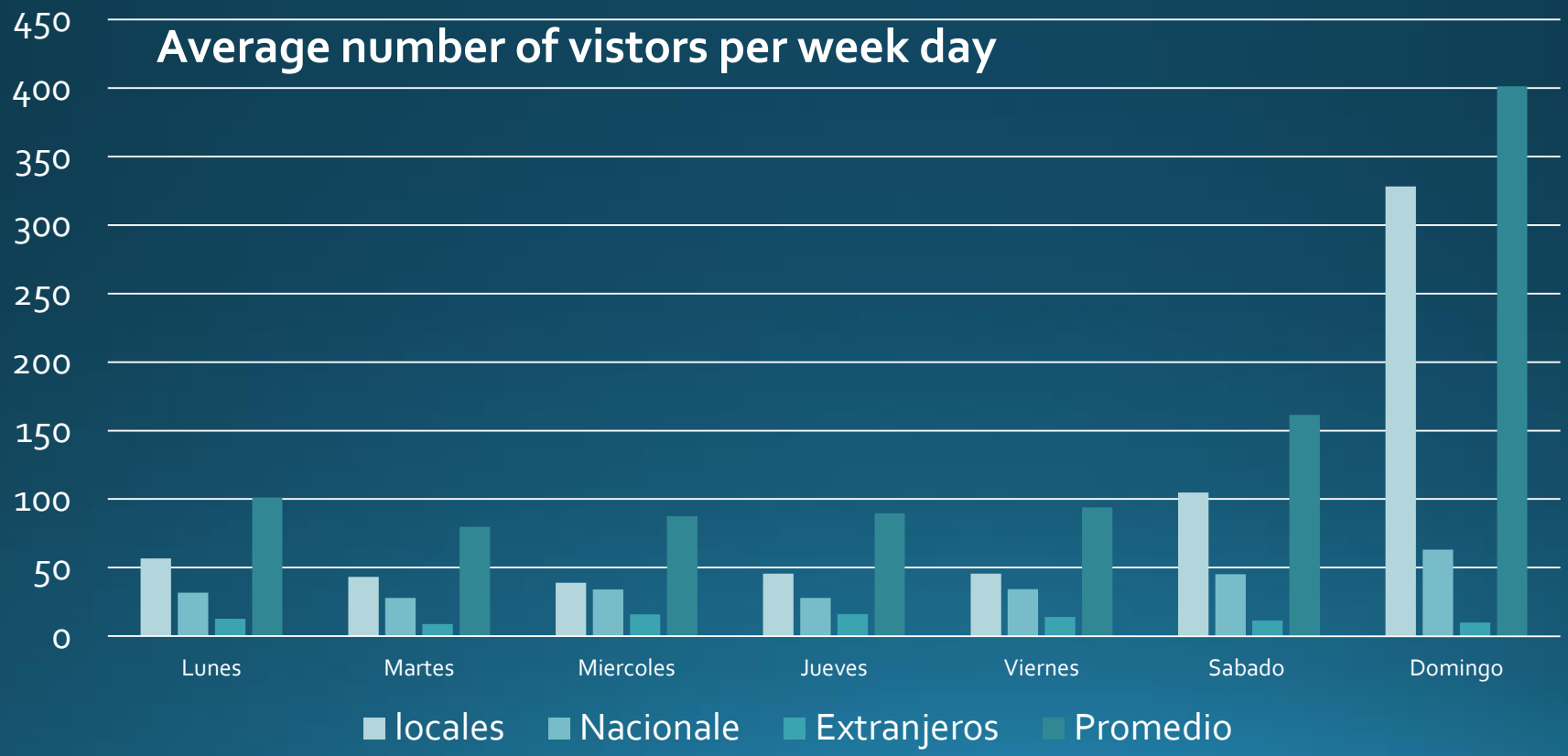
San Antonio Mulix



San Antonio Mulix

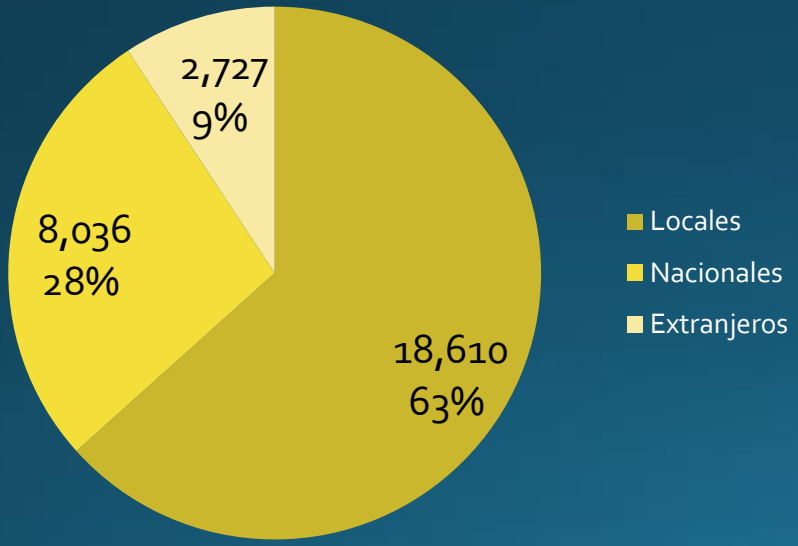


San Antonio Mulix

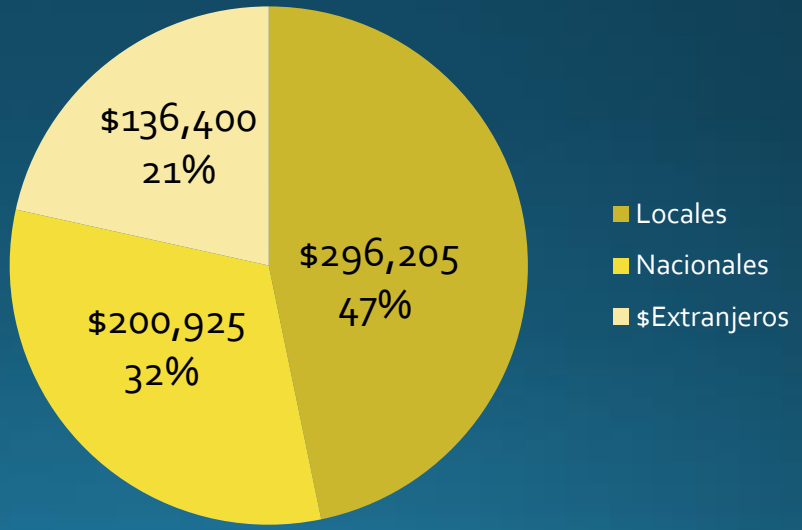


San Antonio Mulix

Total visitors from 1st january to 28th of august 2015

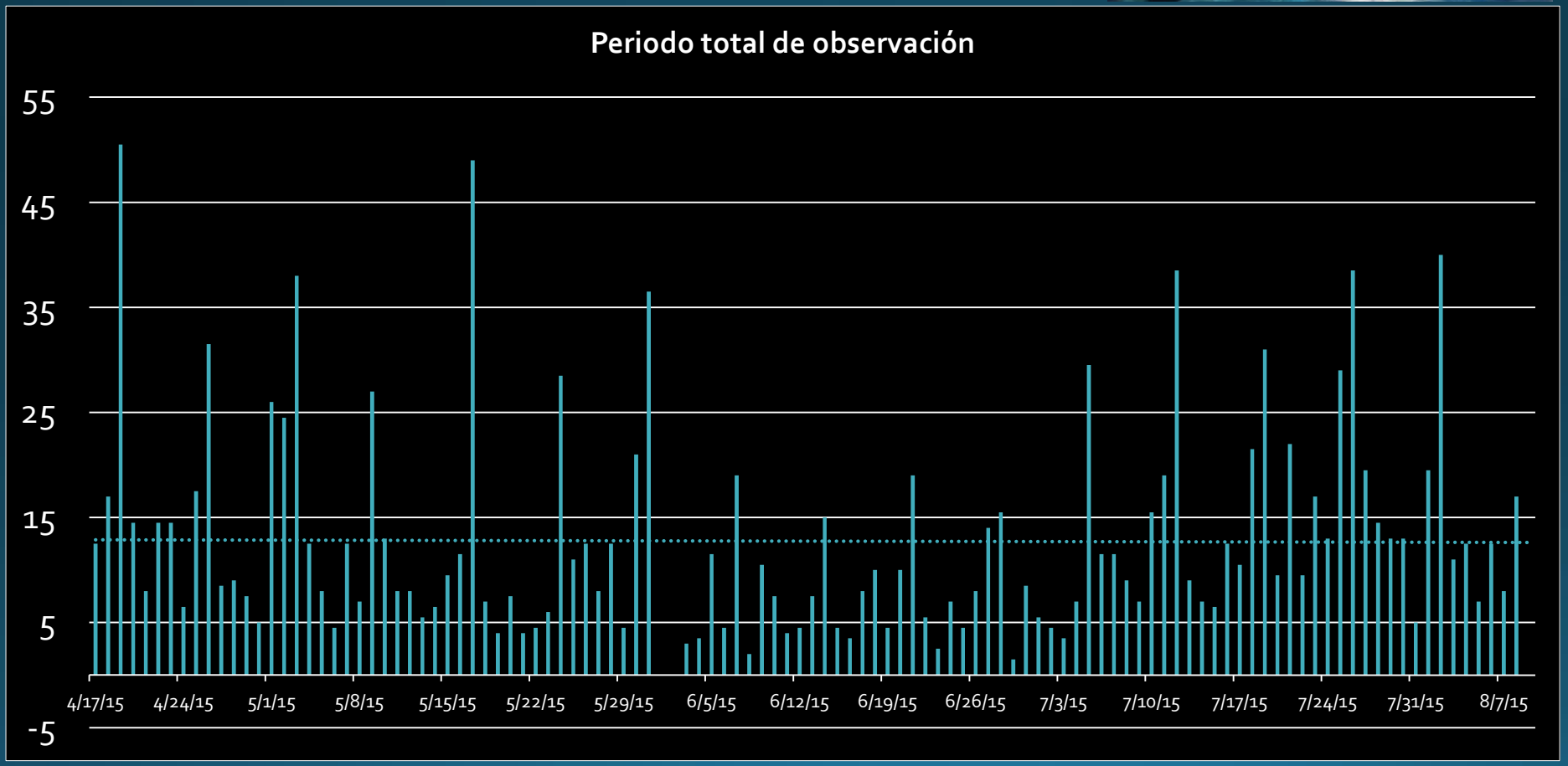


Total earnings from 1st of january to 28th of august



KanKirinxche

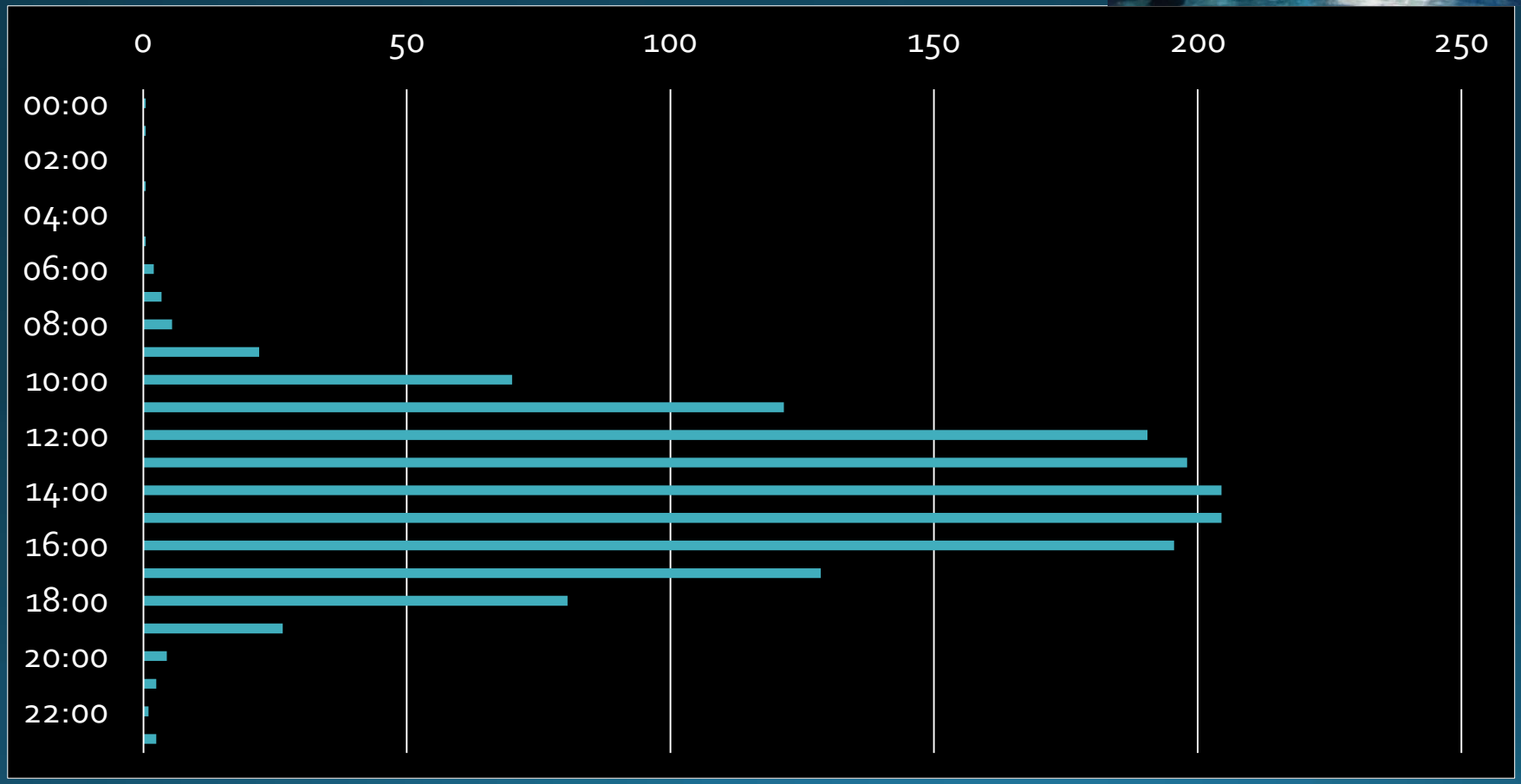
17th april to the 9th of august 2015



1,466 cars registered - 13 cars per day average

KanKirinxche

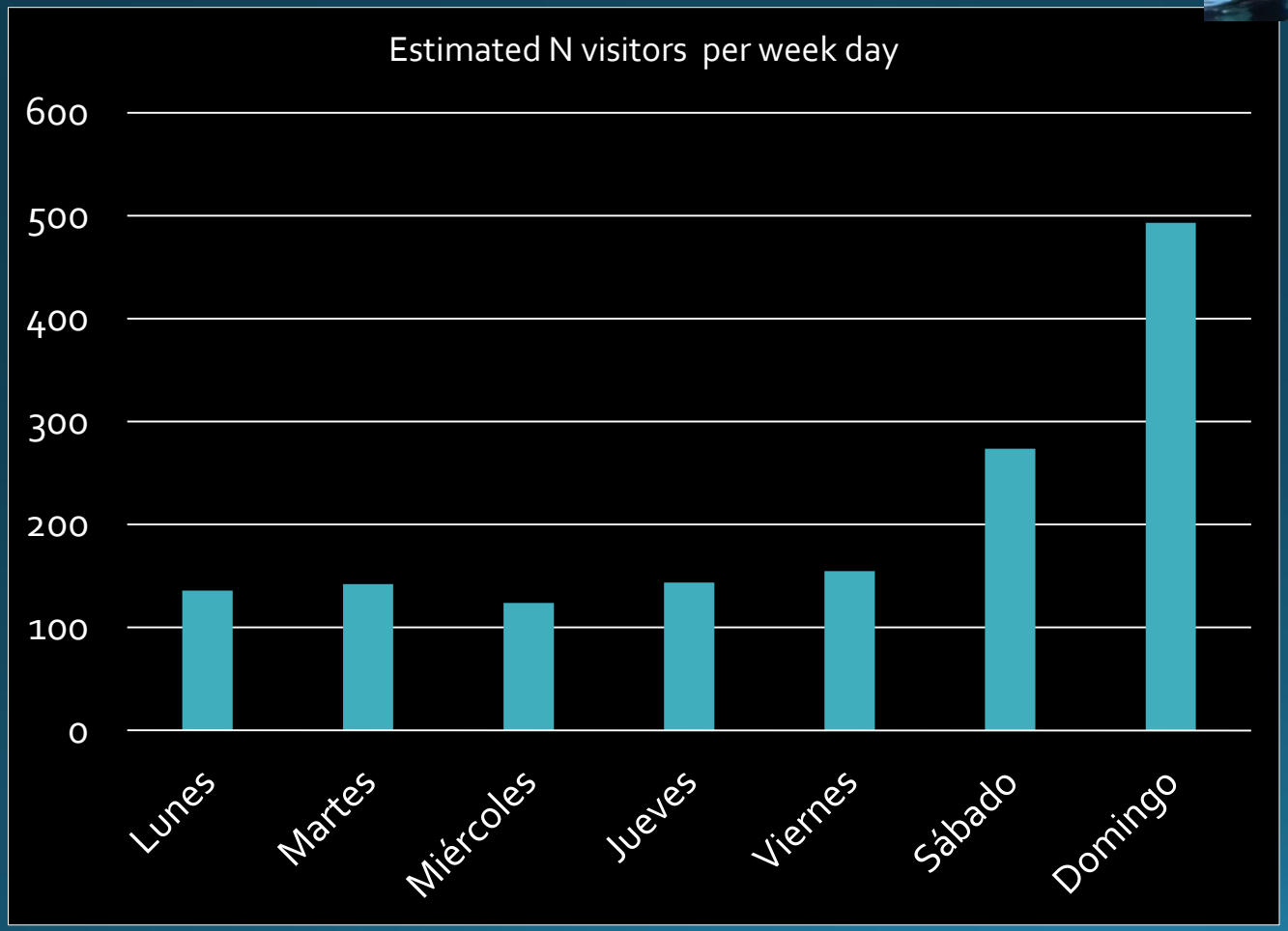
17th april to the 9th of august 2015



12 to 4 PM is the period with more attendance

KanKirinxche

17th april to the 9th of august 2015



Saturday and Sunday represent 53% of the visits per week

Conclusions

Need for:

- Presence/absence biodiversity database
- Long time monitoring of abundance of more conspicuous species
- Detailed database of cenotes descriptors, both geologic, social and economic metrics
- Longtime monitoring of wáter level, temperatura and other wáter quality variables
- Long-term monitoring of cenote usage intensity
- Management plans that take into consideration carrying capacity

Thank you for your attention

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www.bdmy.org