

Analysis of Sea Turtle Nest Temperatures and Future Global Warming Effects on Two Coasts of Mexico

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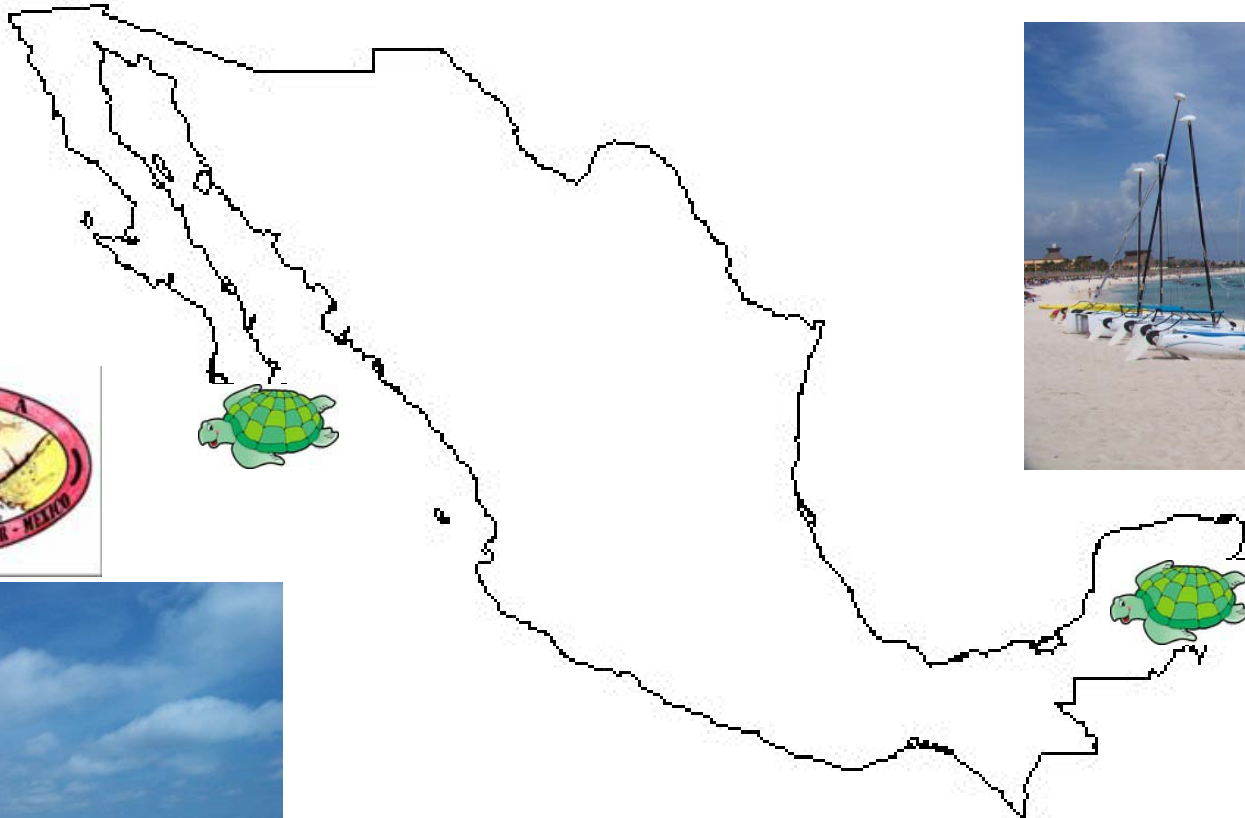
Sea Turtle Internships through The Science Exchange Summer 2010



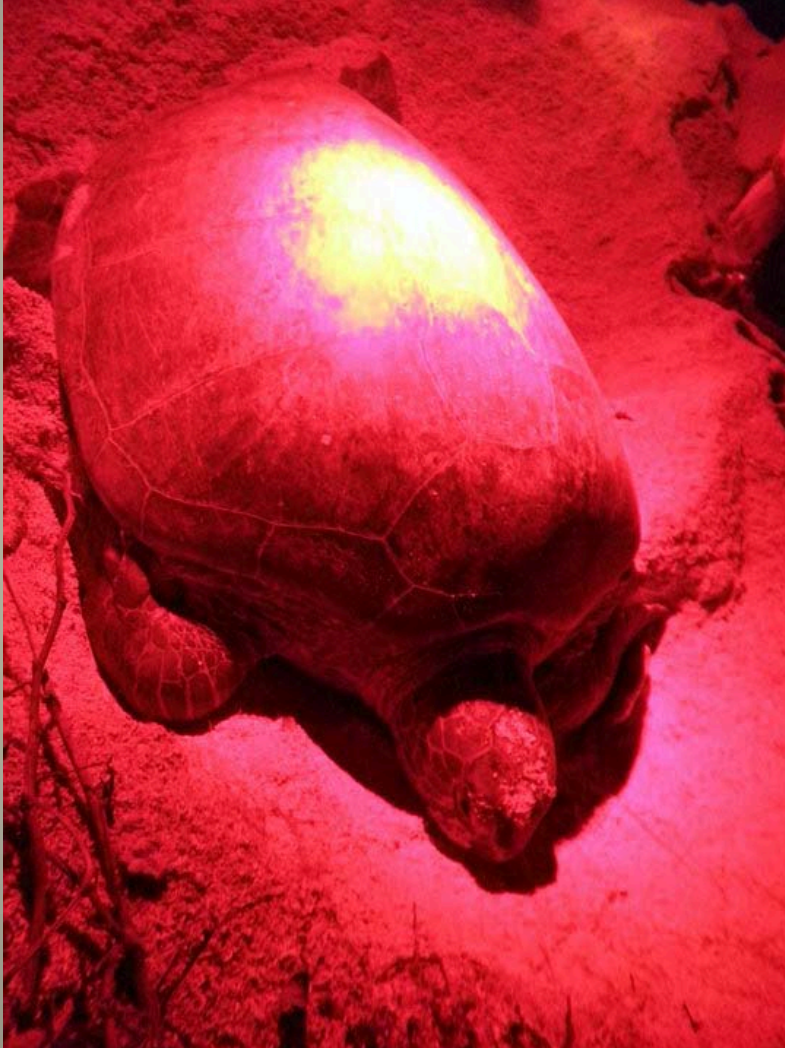
Akumal, Baxter 2010

San Cristobal, Furst 2010

Map of Locations at San Cristobal and Akumal



Problem



Akumal green, Baxter 2010

- Incidental fishing, habitat loss, poaching, pollution, disease, ***lethal nest temperatures due to global warming.***
- Nests in other studies are currently reaching lethal limits (Matsuzawa et al. 1985; Matsuzawa et al. 2002; Hays et al. 2003; Valverde et al. 2010; Fuentes et al. 2010).

Research Questions

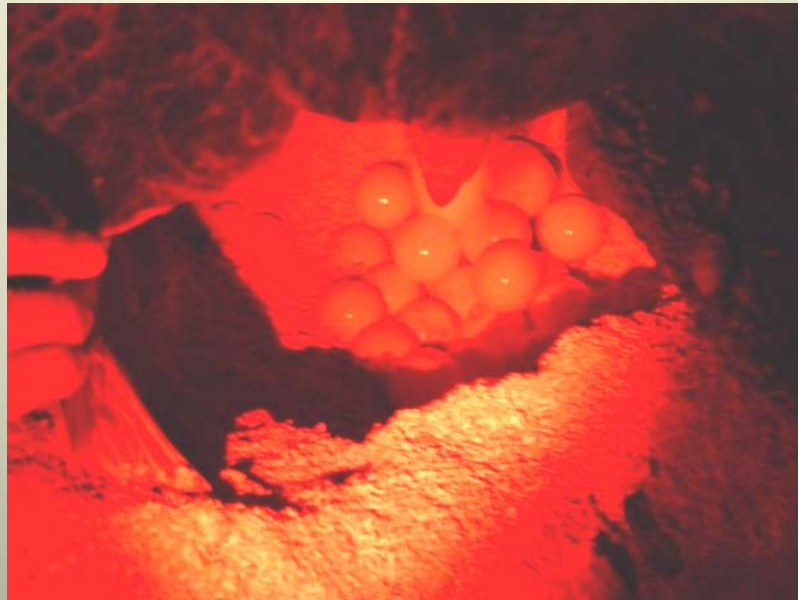
1. Are nests in our study areas currently in danger of reaching lethal limits?
2. Can we use regional weather station data to monitor our study sites? (Is there a significant correlation?)
3. Can we use weather data to monitor sand temperatures at our study sites? (Is there a significant correlation?)
4. Will global warming cause sand temperatures in 2100 reach lethal limits on these beaches?



Nadia releasing hatchlings in Akumal, Baxter 2010

Assumptions

- Metabolic heat produces about 1.7 C of heat compared to surrounding sand temperature (Segura and Cajade 2010).
- The lethal limit for embryos occurs at around 34C (Bustard and Greenham 1968; McGehee; 1979; Yntema and Mrosovsky 1980; Miller et al. 2003)



Akumal, Baxter 2010

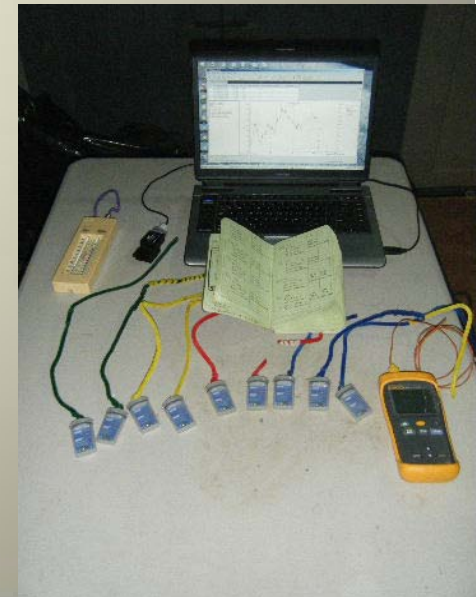
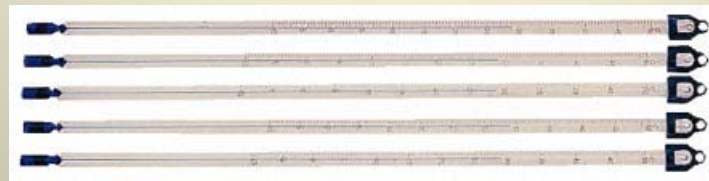
Assumptions (cont.)

- Future air temperatures were modeled by the Intergovernmental Panel on Climate Change and are predicted to rise about 1.8 C by 2100 (IPCC 2007)



Methods and Materials

- Followed Hawkes et al. 2007 and Gallegos et al. 2009
- Walked daily to check sand thermometers buried at nest levels in different areas of Akumal and San Cristobal beaches
- Measured daily climate variables at the beaches
- Downloaded weather data from local weather stations



Variables

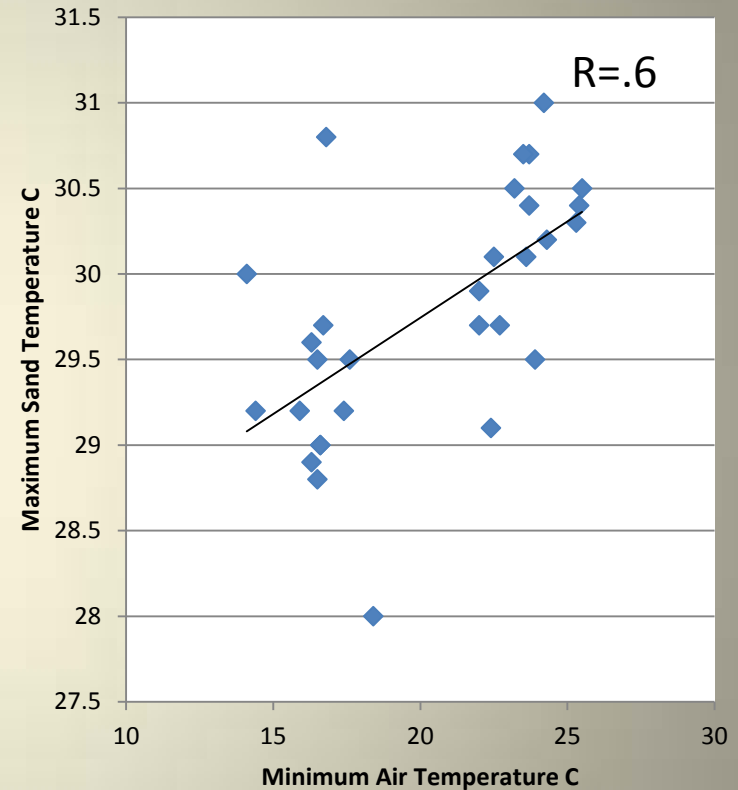
- **Dependent:**
 - max sand temperature
- **Independents:**
 - min and max air humidity
 - min and max air temperature
 - dew point
 - wind speed
 - precipitation
- **Used a Pearsons Correlation Matrix**
(PSPP freeware)



Akumal, Baxter 2010

Results

- Only minimum air temperature was sig. correlated with maximum sand temperatures
- R values =
 - 0.64 at Akumal
 - 0.68 at San Cristobal ($p < .05$)
- Consistent with previous studies
 - 0.44 (Hurtado unpubl. 2008)
 - 0.49 (Maxey 2009) ($p < .05$)
 - 0.42 from Junquillal, CR (Gallegos et al. 2009)



Example of one sensor at Akumal

Global warming prediction

- We used the R values to extrapolate temperature change

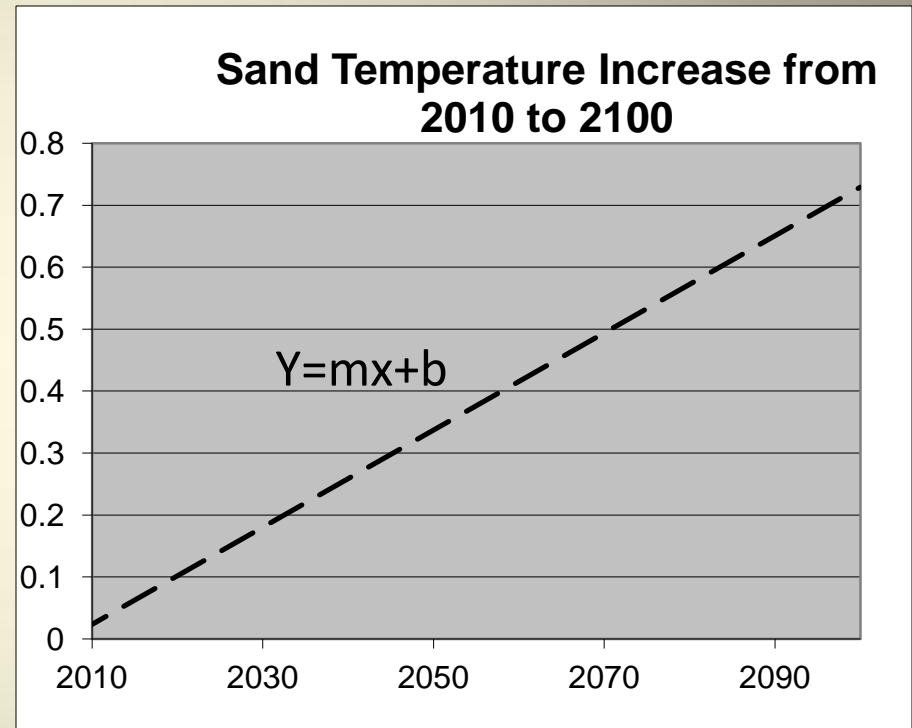
$y = \text{change in sand temp}$

$m = \text{slope or } R$

$x = \text{increase in air temp (1.8 C)}$

$b = 0$

- 2100 predicted sand temperatures will increase by:
 - 1.22 C at Akumal
 - 1.15 C at San Cristobal



Results: Predicted Global Warming Effects on Sand Temps

Akumal 2010

Location	Mean Temperature (includes 1.7 C for metabolic heat)	CI (alpha = .05)	2100 Temperatures (=1.22 C increase)
AB Sand Temp Max	30.5	(+/-) 0.19	31.7
HMB Sand Temp Max	31.4	(+/-)0.22	32.6
PT Sand Temp Max	30.4	(+/-)0.22	31.6

Results: Predicted Global Warming Effects on Sand Temps

San Cristobal Beach 2010

Location	2010 Temperature (includes 1.7 C for metabolic heat)	CI (alpha = .05)	2100 temperatures (=1.15 C increase)
Temp 1	28.6	(+/-)0.51	29.7
Temp 2	28.8	(+/-)0.34	29.9
Temp 3	29.8	(+/-)0.38	31.0
Temp 4	30.7	(+/-)0.33	31.9
Temp 5	30.5	(+/-)0.41	31.7
Temp 6	30.9	(+/-)0.28	32.1
Temp corral	29.8	(+/-)0.37	30.9
Hobo	30.9	(+/-)0.38	32.0

Previous Studies in Baja California Sur, Mexico

San Cristobal 2008 (Hurtado unpubl.)

Location	2008 Temperature (includes 1.7 C for metabolic heat)	2100 temperatures (.89 C increase)
Sensor 1	32.4	33.3
Sensor 3	32.4	33.3
Sensor 4	32.6	33.5
Sensor 5	33.1	34.0

San Jose del Cabo 2008 (Maxey et al. 2009)

Location	2008 Temperature (includes 1.7 C for metabolic heat)	2100 temperatures (.81 C increase)
Presidente Hatchery estuary side	33.5	34.3
Presidente Hatchery	33.1	33.9
Playa Tortuga zone B	31.9	32.7
Playa Tortuga zone C	34.0	34.8
Playa El Cardoncito zone B	34.3	35.1
Playa El Cardoncito zone C	34.2	35.0
Playa La Fortuna zone B	33.3	34.1
La Fortuna Hatchery	34.6	35.4

Conclusions

1. Several zones in **San Jose del Cabo in 2008 reached lethal limits**, our studies in **2010 stayed around 31 C**
2. Regional weather stations did ***not*** serve as surrogates for local weather data in our study



Akumal, Baxter 2010

Conclusions (cont.)

- 3. Minimum air (night) temperatures** were consistently and significantly correlated with the maximum sand temperatures, although only explaining about half the variation.
- 4. Prediction: 2100 sand temperatures will likely reach lethal levels on the in Baja California.**



Conservation Recommendations

- If night-time temperatures stay high for a period of time – check your nest temperatures!
- If sand temperatures get high, use shade to cool nests



Research Recommendations

- Longer study period, more study locations
- Standardize equipment, Nest cages to protect hobos
- Study sand moisture, color, grain size, compaction
- Predict effect of global warming on sex ratios
- Quantify time lag to heat/cool sand



Courtesy of Sea Turtle Municipal Program
Cabo San Lucas 2007

More questions...if sand temperatures rise

- Will sea turtles respond with a shift in seasons?
- Shift in latitude?
- Shift in pivotal temperature?
- Shorter incubation times?
- Will these responses help/harm turtle populations?
- Will responses happen quickly enough?



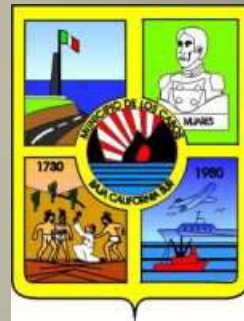
Puerto Vallarta, Katherine Santos

Gracias!



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