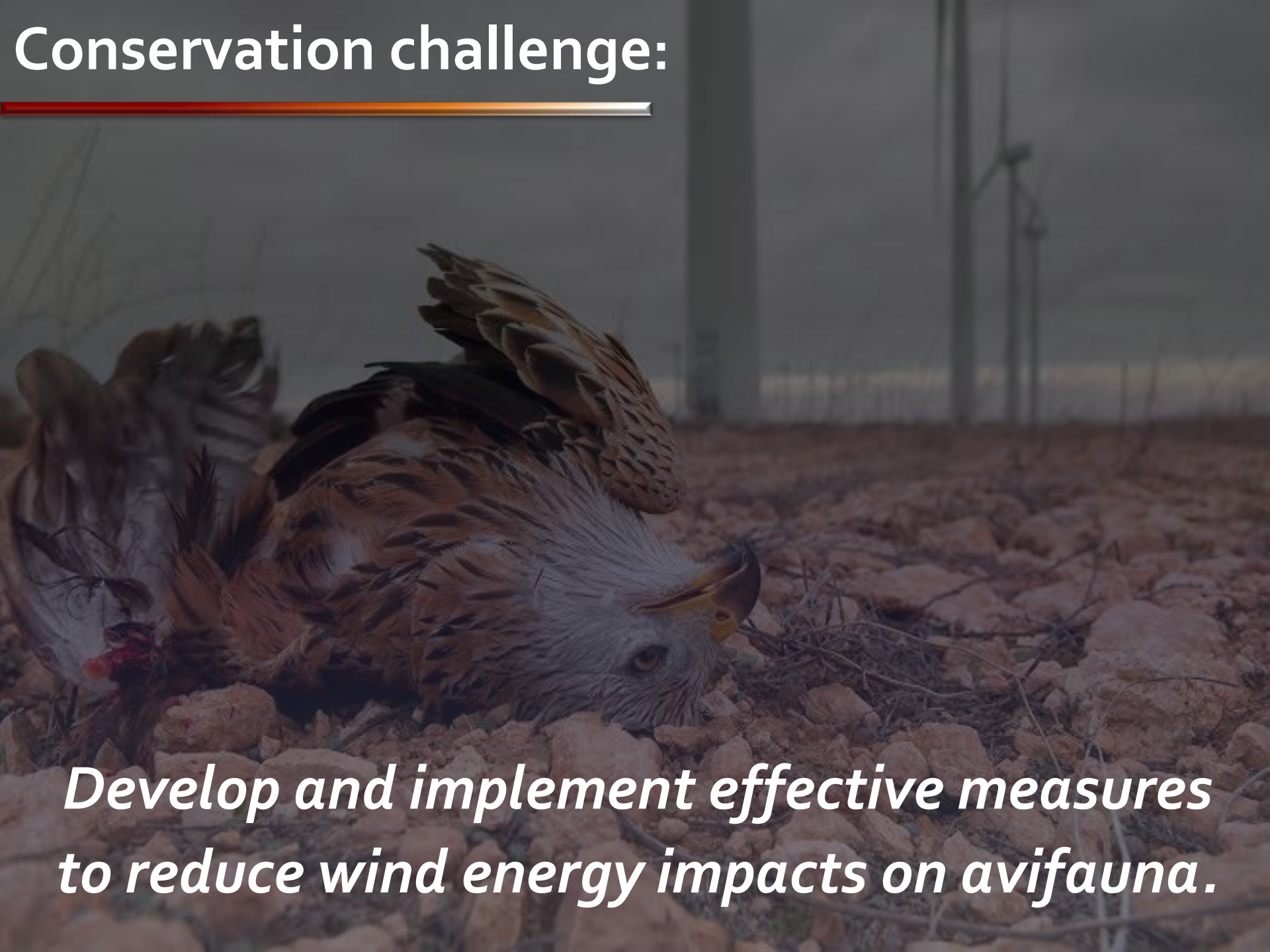
Curtailing Avian Impacts with Wind Turbines using GSM/GPS Tracking Telemetry that Incorporates Autonomous Geofence Alerts

- James K. Sheppard PhD: *San Diego Zoo Global*
- Andrew McGann: *Cellular Tracking Technologies*
- Michael Lanzone: *Cellular Tracking Technologies*
- Allyson Walsh PhD: *San Diego Zoo Global*
- Michael Wallace PhD: *San Diego Zoo Global*
- Ronald Swaisgood PhD: *San Diego Zoo Global*

Conservation challenge – what we know

- Wind energy continues to proliferate globally.
- Wind farms have environmental costs.
- Growing literature documenting impacts on resident and migratory avifauna populations.
- Hard data on raptor impacts scarce - but impacts do occur
  - e.g., Pagel et al. (*J. Raptor Res.* 2013) found a minimum of 85 eagle mortalities at 32 wind farms in 10 states, 1997 – 2012.

Conservation challenge:



Develop and implement effective measures to reduce wind energy impacts on avifauna.

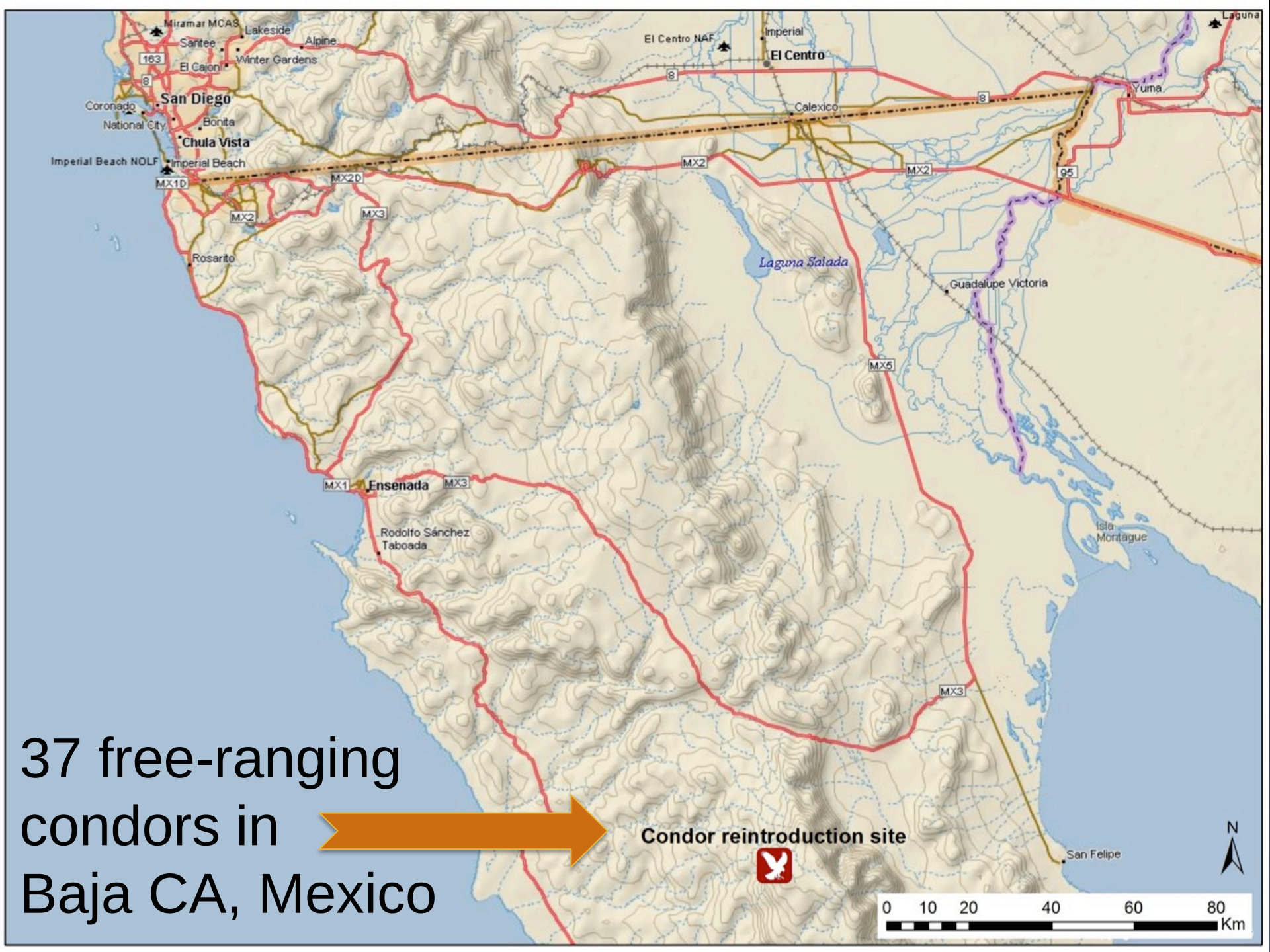
Conservation challenge: Condors & Wind Energy

Condors & Wind Energy

- No definitive record of wind turbine impact injury

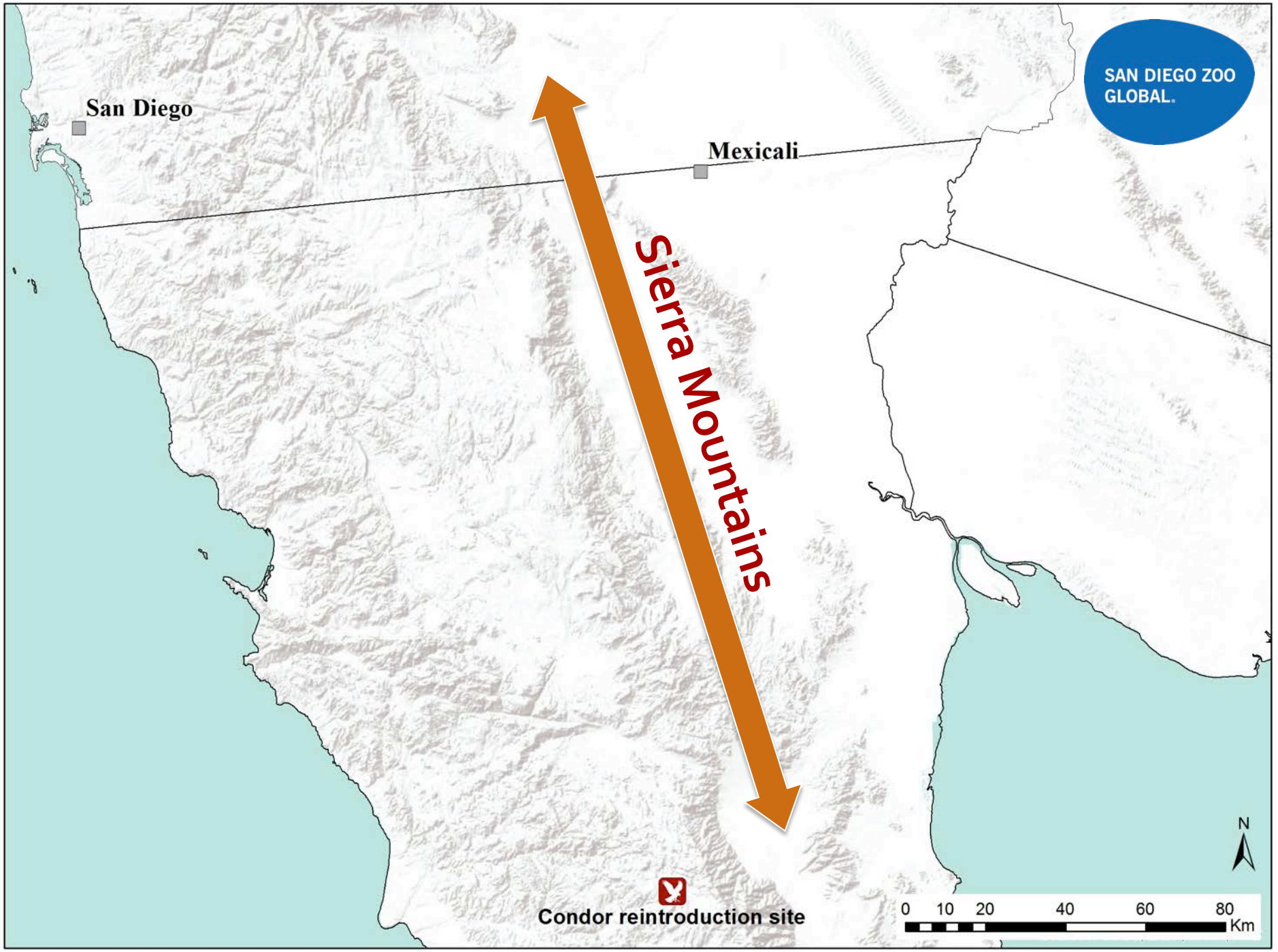
to date… However…

- Condors are expanding their ranges, including areas of existing & proposed wind energy development.
- Wind energy has potential to conflict with condor recovery unless collision risks are minimized.


37 free-ranging condors in Baja CA, Mexico
Condor reintroduction site
Miramar MCAS
Lakeside
Alpine
Santee
El Cajon
Winter Gardens
San Diego
Coronado
National City
Bonita
Chula Vista
Imperial Beach NOLF
Imperial Beach
El Centro NAF
Imperial
El Centro
Calexico
Yuma
Laguna
Laguna Salada
Guadalupe Victoria
Rosarito
Ensenada
Rodolfo Sánchez Taboada
Isla Montague
San Felipe
MX1D
MX2D
MX2
MX3
MX1
MX5
163
8
95
N
0 10 20 40 60 80
Km

- Condors select habitats with <u>strong and consistent winds</u> to help them soar long distances while minimizing energy.

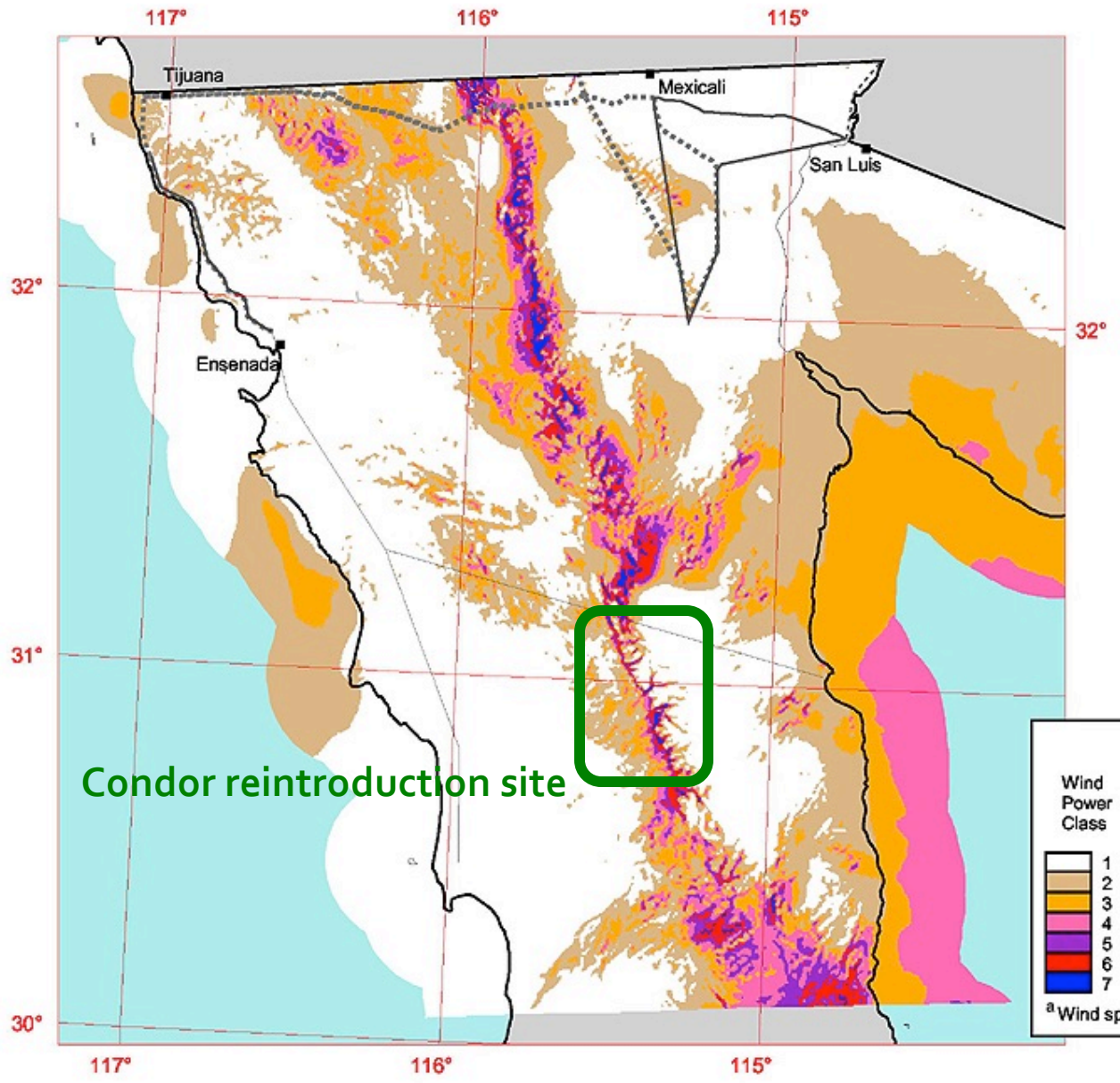
- Condors fly slowly and tend to watch the ground for activity while soaring.


SAN DIEGO ZOO GLOBAL.
San Diego
Mexicali
Sierra Mountains
Condor reintroduction site
N
0 10 20 40 60 80
Km

Baja California Norte

Border Region

50 m Wind Power



Transmission Line*
Voltage (kV)
69
115 - 161
230
345
* Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies

The annual wind power estimates for this map were produced by TrueWind Solutions using their Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

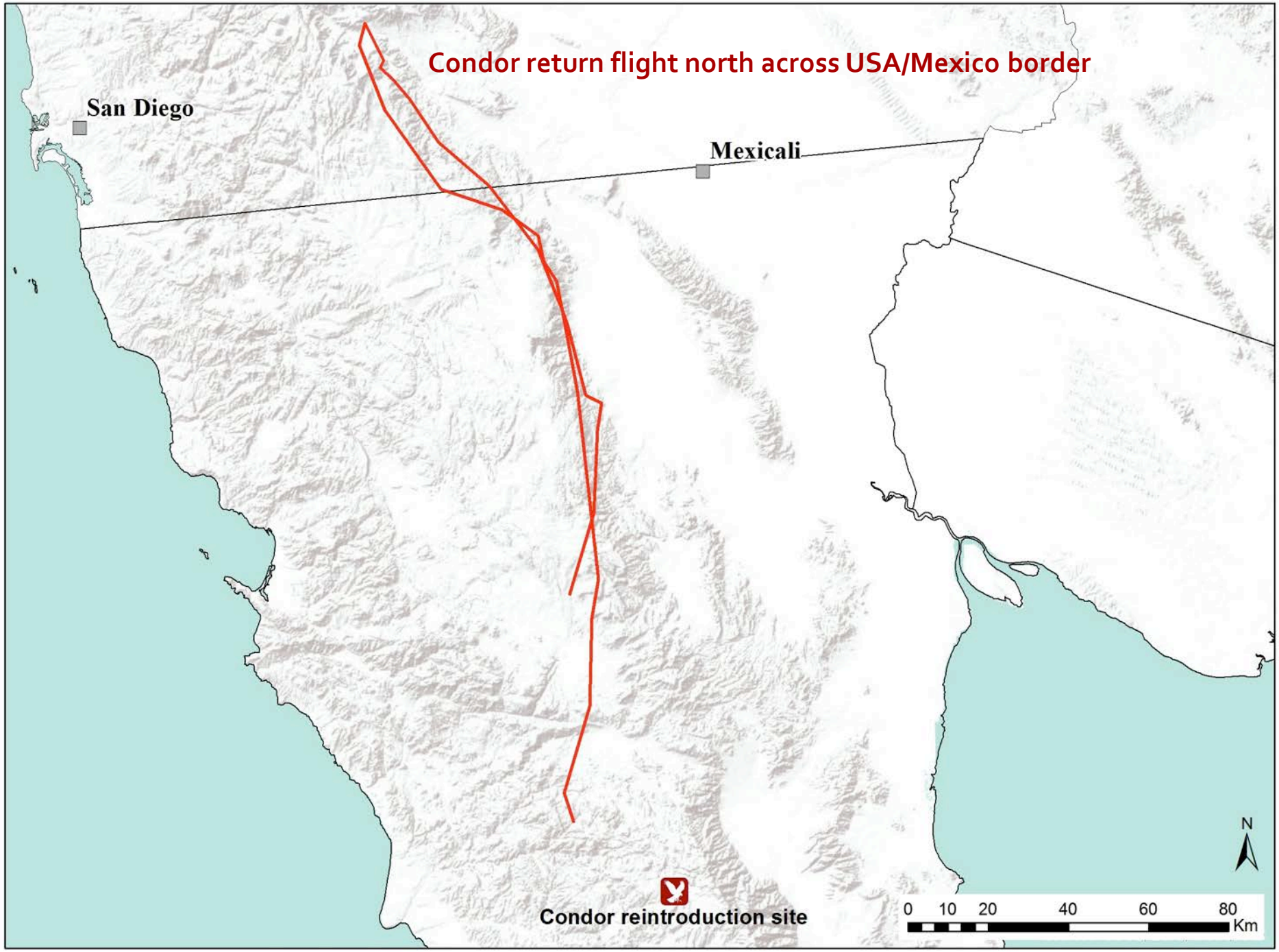
Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
1	Poor	0 - 200	0.0 - 5.6	0.0 - 12.5
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	> 800	> 8.8	> 19.7

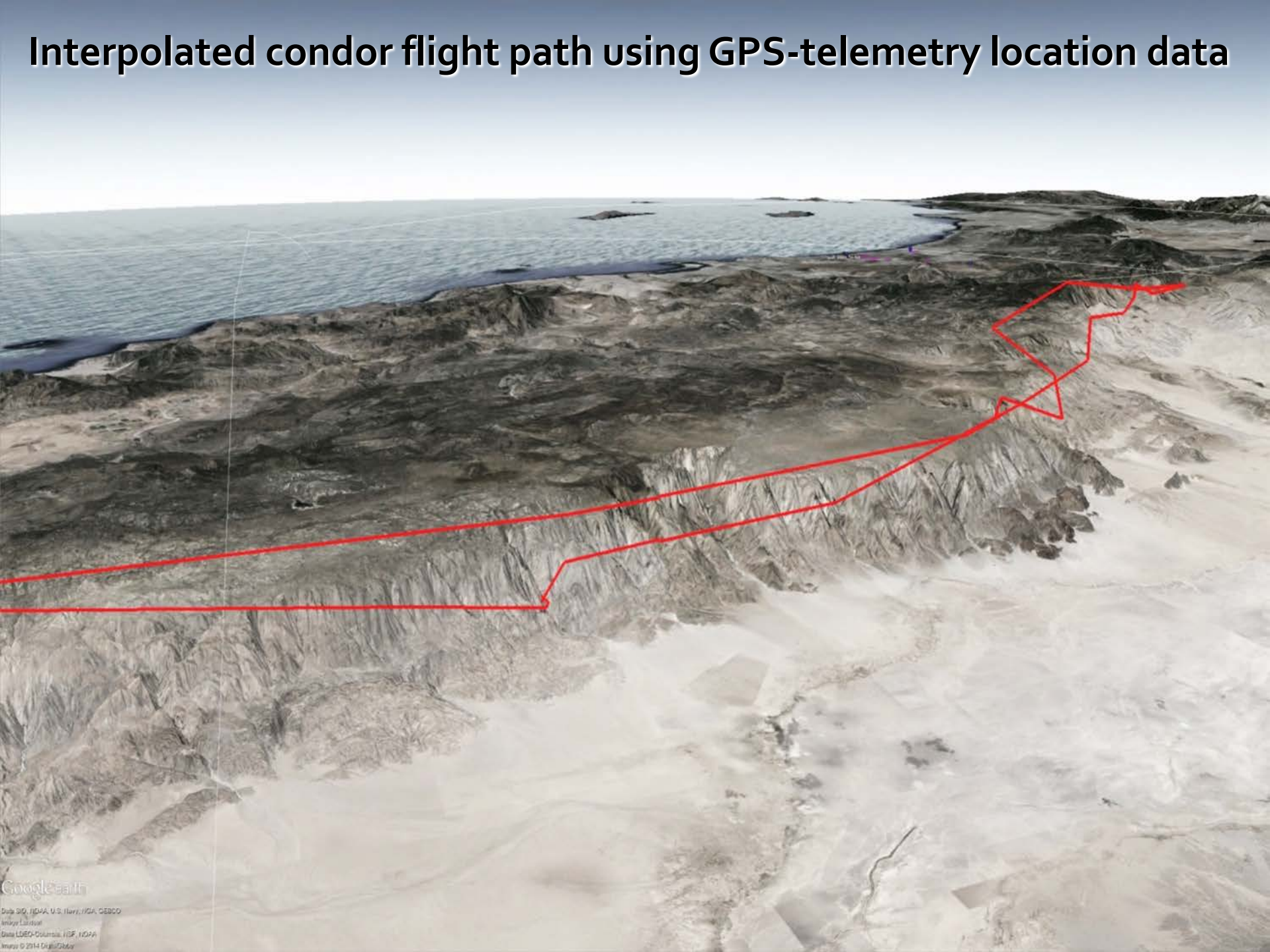
[a] Wind speeds are based on a Weibull k of 2.0 at sea level.

20 0 20 40 60 80 100 120 Kilometers
20 0 20 40 60 Miles

NREL
U.S. Department of Energy
National Renewable Energy Laboratory
06-FEB-2004 1.1.2


Condor return flight north across USA/Mexico border
San Diego
Mexicali
Condor reintroduction site
N
0 10 20 40 60 80
Km

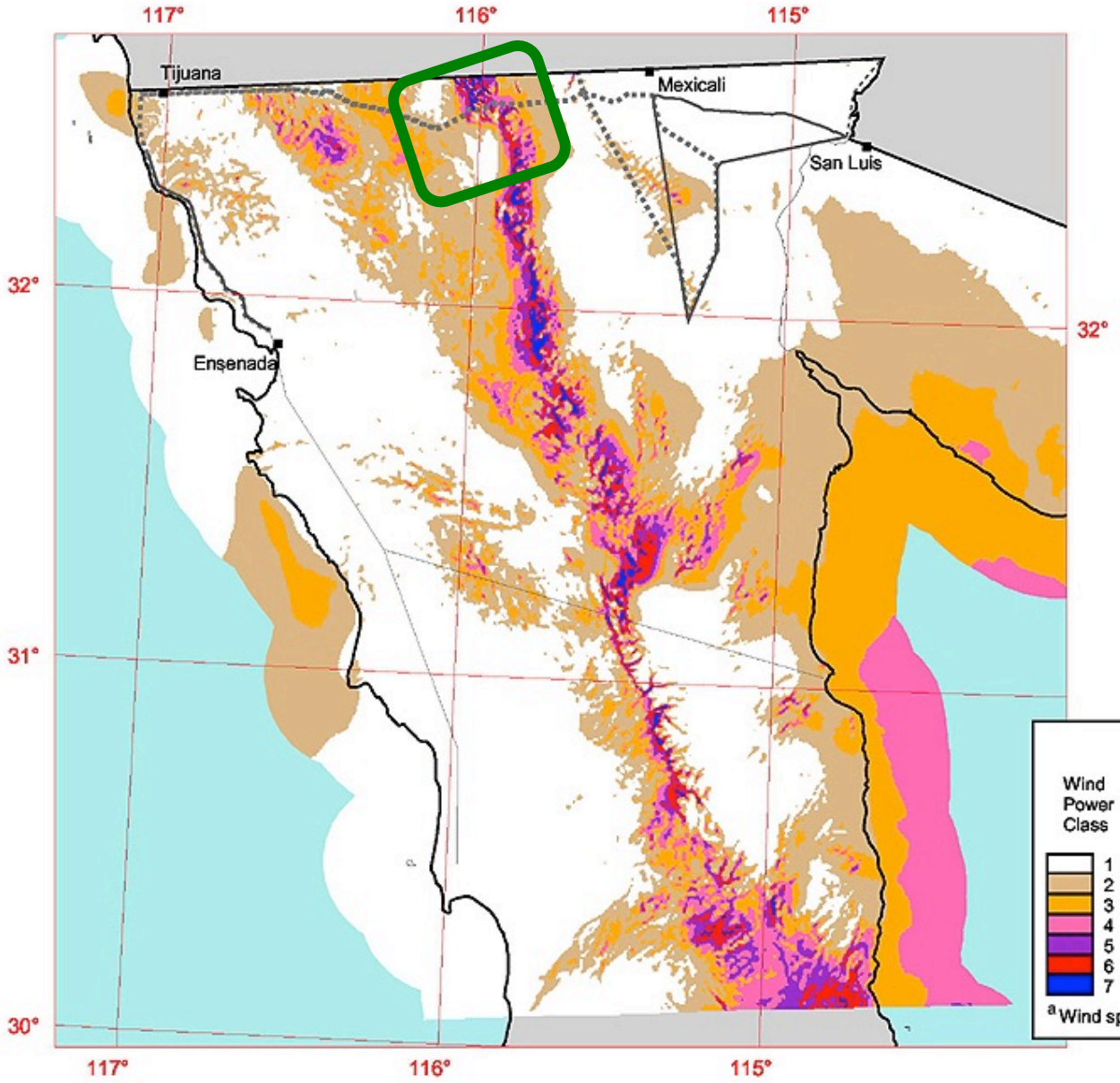
Interpolated condor flight path using GPS-telemetry location data



Baja California Norte

Border Region

50 m Wind Power



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- 345

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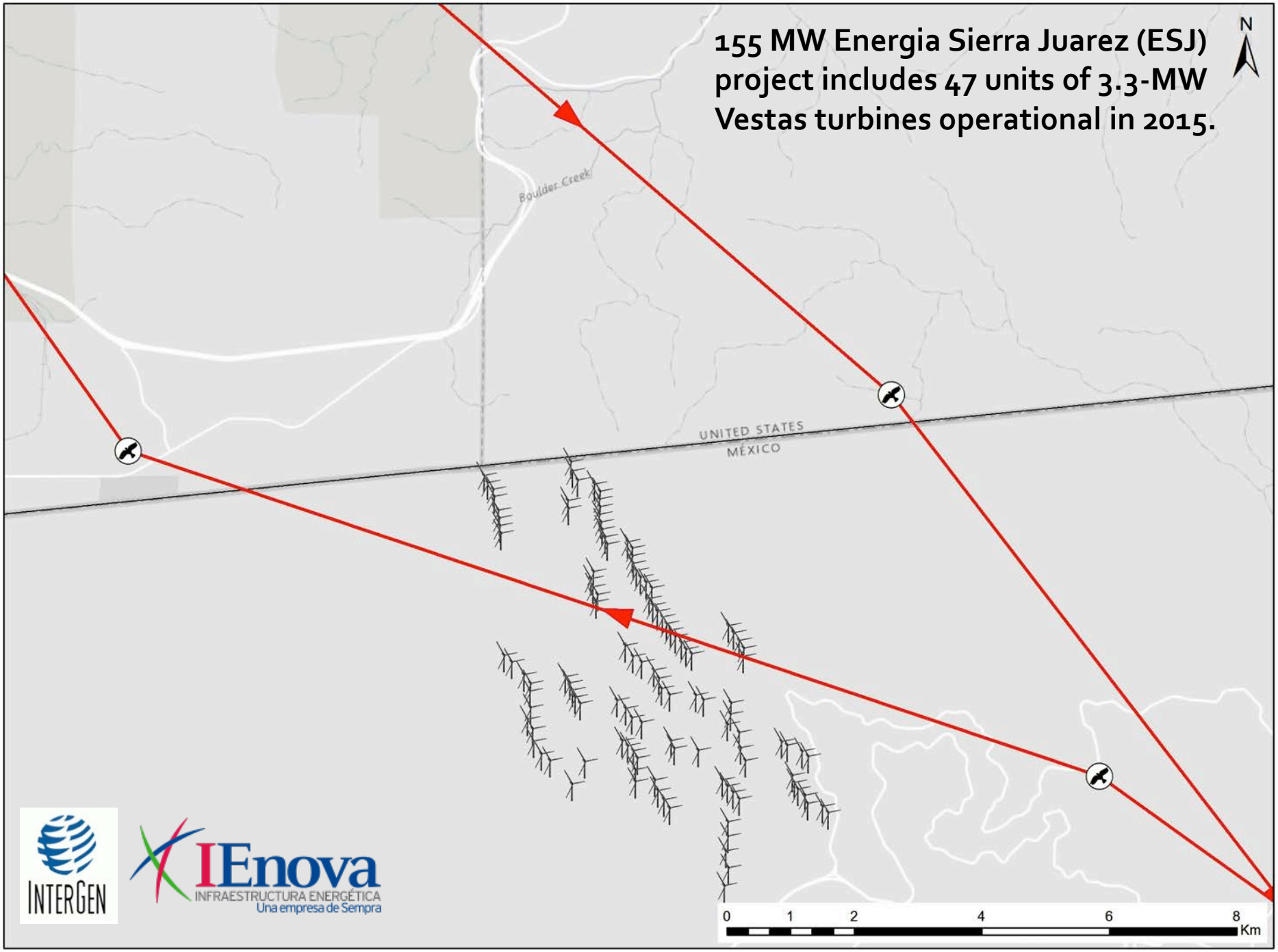
20 0 20 40 60 80 100 120 Kilometers

20 0 20 40 60 Miles

U.S. Department of Energy
National Renewable Energy Laboratory

06-FEB-2004 1.1.2

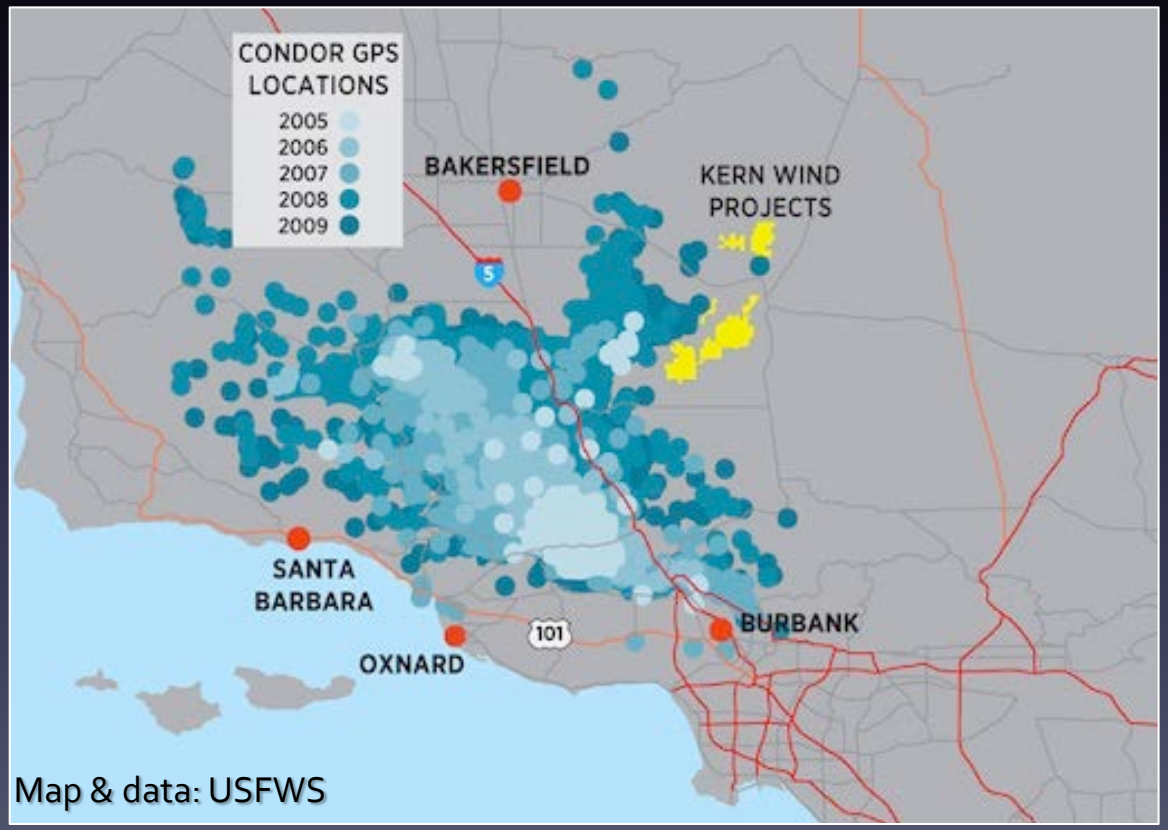

155 MW Energia Sierra Juarez (ESJ) project includes 47 units of 3.3-MW Vestas turbines operational in 2015.
N
Boulder Creek
UNITED STATES
MÉXICO
INTERGEN
IEnova
INFRAESTRUCTURA ENERGÉTICA
Una empresa de Sempra
0
1
2
4
6
8
Km

“Let them bring hundreds, thousands of turbines…”

Baja California Gov. José Guadalupe Osuna Millán
- San Diego Union-Tribune

Condors & Wind Energy

- Controversial <u>incidental condor take</u> permits considered for USA wind farms…



Map & data: USFWS

KCET SHOWS NEWS ARTS LIVING S

Re wire

News and analysis about renewable energy in California.

WIND

Killing a Condor is Okay at Wind Project, Feds Say in About-Face Move

by Chris Clarke | May 14, 2013 2:10 PM

SHARE Tweet 0 8+1 0 Like 0

Month-old condor chick with mom. | Photo: FWS/Flickr/Creative Commons License

In a reversal that has outraged environmentalists, the U.S. Fish and Wildlife Service (FWS) announced it will not penalize a Southern California wind operator if its turbines kill or injure one California condor. One of the world's most critically endangered animals with fewer than 250 birds in the wild, the condor's range in the Tehachapi Mountains is being encroached on by intensive wind turbine development.

Technological solutions

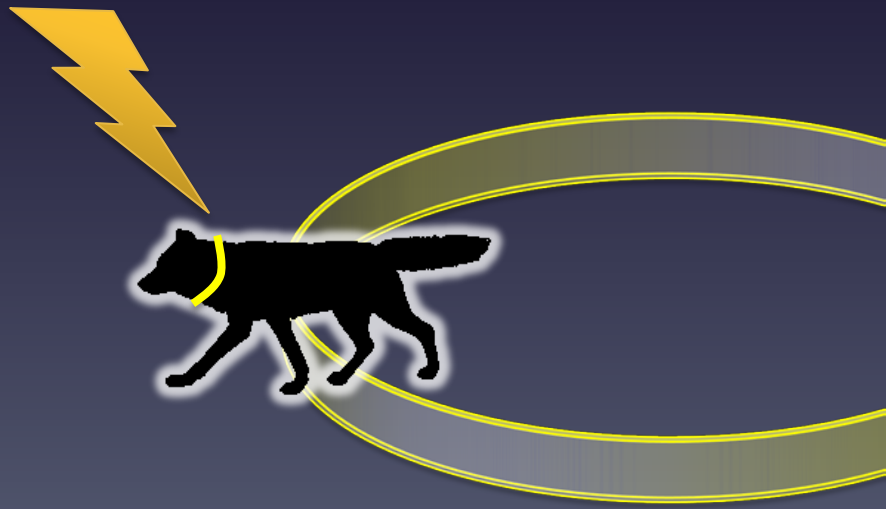
Rapid advances in the miniaturization, accuracy and utility of biotelemetry devices offer technological solutions to curtail avian fatalities.

- Develop a biotelemetry system to provide automated alerts if a telemetered bird flies close to a wind farm.

- Provide time to implement appropriate measures to curtail collision risk.

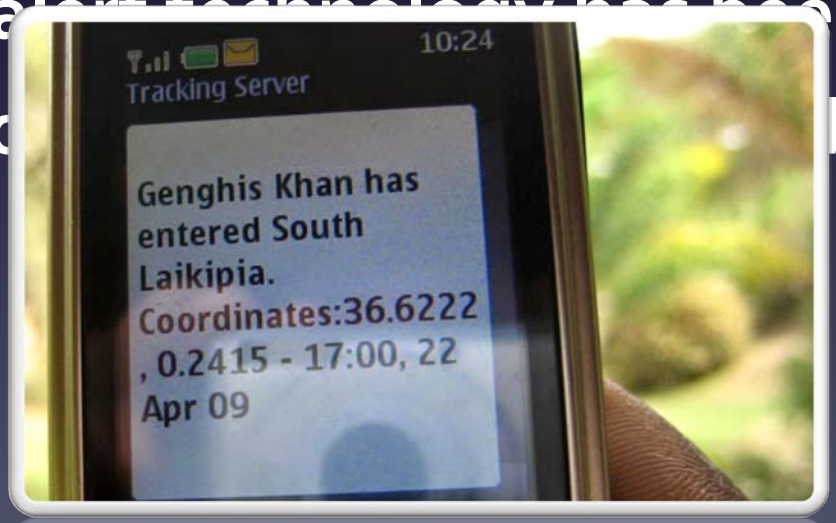
Real-time virtual fences (geofences)

- Incorporated geofence technology into avian GPS-tags to provide early-warning capability for large bird species.
- Geofence is a virtual boundary delineated around an area of interest that triggers:
  - A cue to the telemetered animal
  - Change in the location fix rate
  - An alert.



Real-time virtual fences (geofences)

- Geofences increasingly used as an effective platform to enhance the spatiotemporal flexibility of wildlife management.
- Geofence a[illegible] to complex to[illegible] biot



Raptor geofence alert system

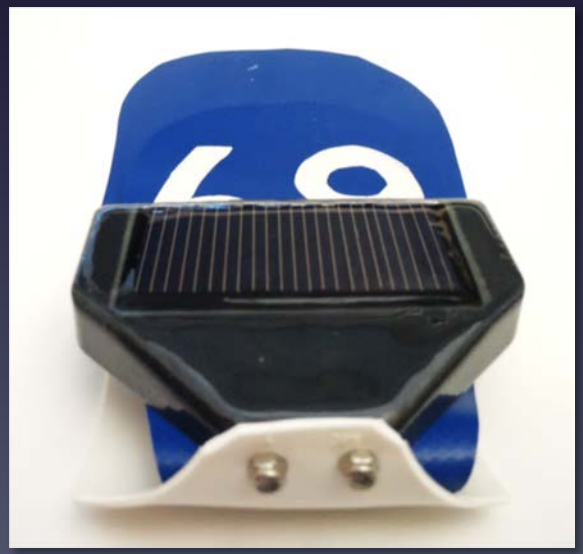
- First autonomous GPS geofence alert system specifically for avian applications to minimizing collisions risk.
- SMS warning message sent to secure receiver group.
- Appropriate collision avoidance response initiated.

CELLULAR TRACKING TECHNOLOGIES

SAN DIEGO ZOO GLOBAL

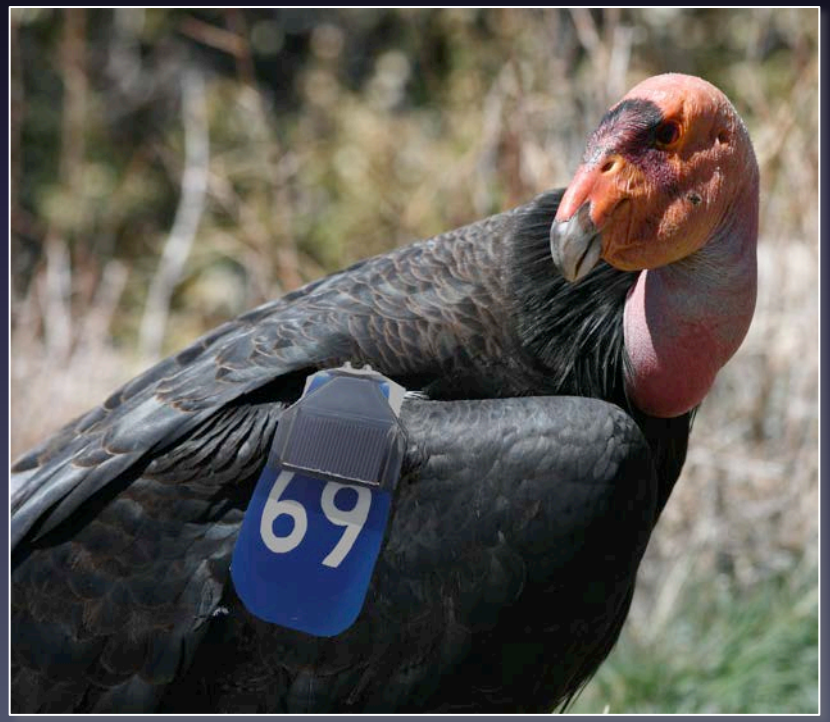
Raptor geofence alert system

- CTT-1050a-PM Series GPS-GSM (2 Gen), Advanced Bird Telemetry System.
- Weatherproof enclosure with internal antenna.
- Tags weigh ~45g, 80 mm x 62 mm x 10 mm (W x L x H).



Raptor geofence alert system

- Backpack mount for large birds such as eagles and herons.
- Patagial wing mount for condors.



Raptor geofence alert system

- Powered by a solar-recharged Lit-Ion Polymer battery.
- Reprogrammable duty cycle - GPS location fix rate originally set at 15 min.
- Fix rate will decrease to 30 s if the tag *enters* a geofence and return to 15 min when it *leaves* the geofence zone.

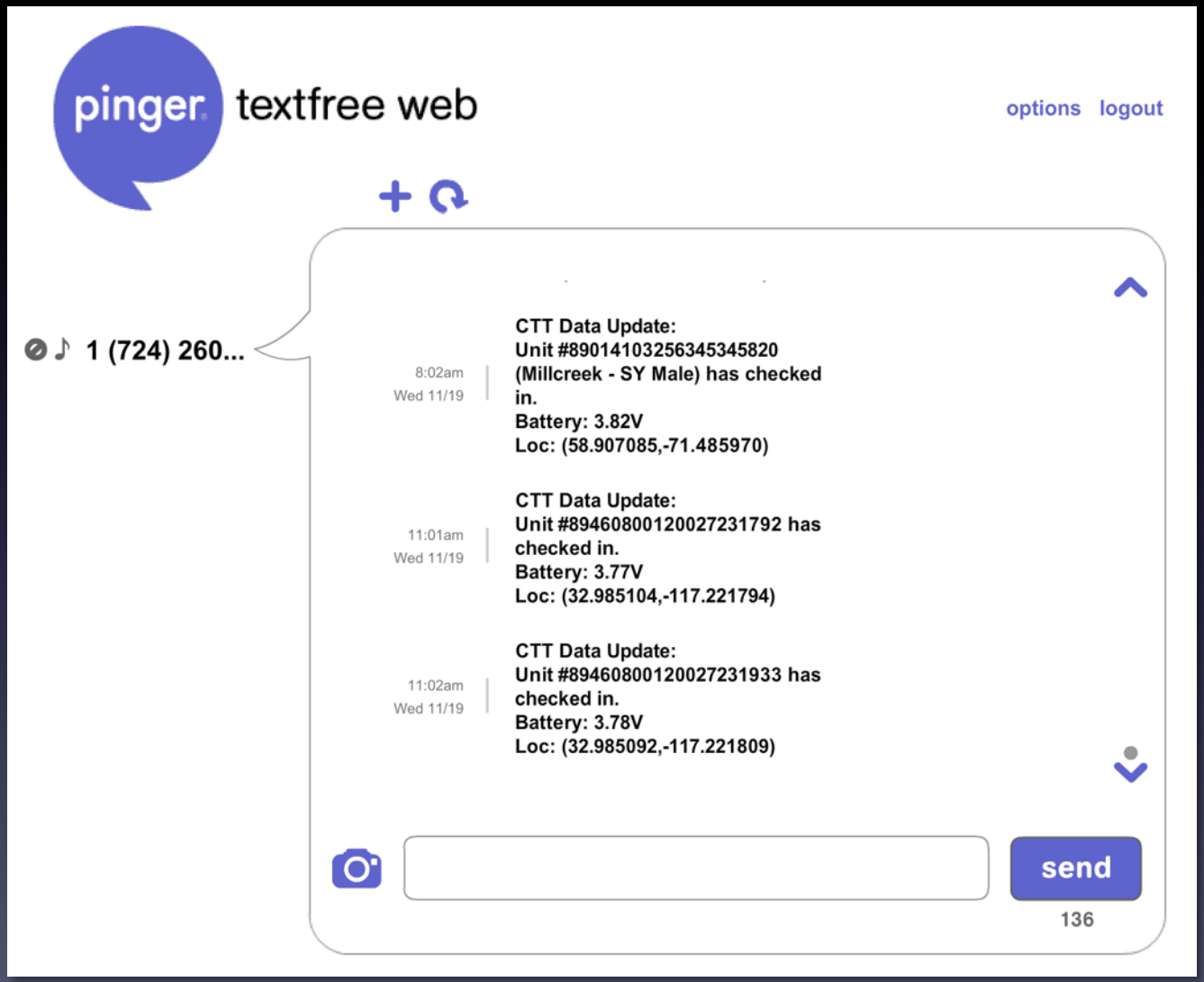
Raptor geofence alert system

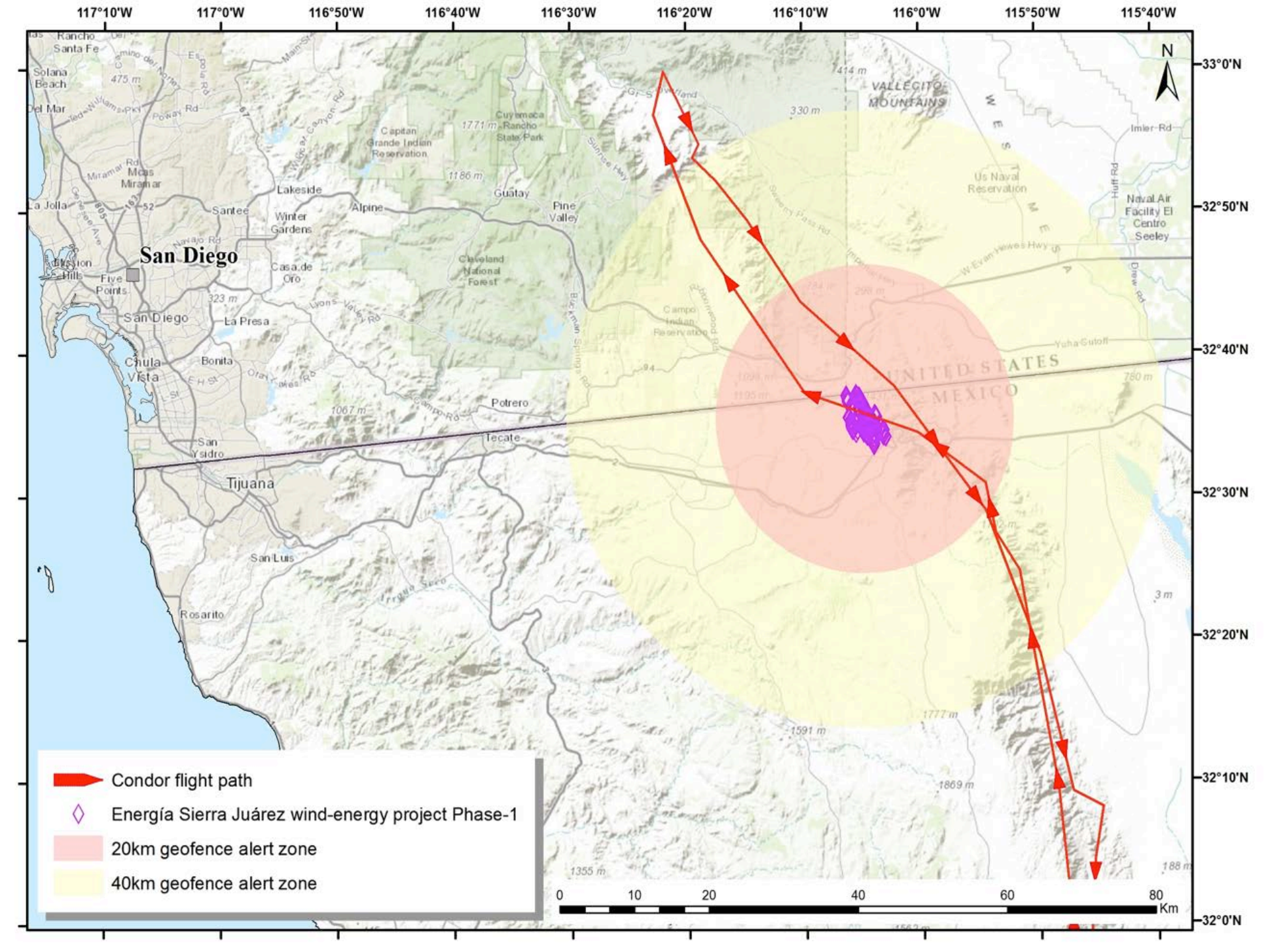
- GSM (cellular) network communication to transmit location data.
- If coverage is unavailable > 100,000 GPS location fixes stored.
- Cellular system allows tags to frequently update large batches of telemetry data at low costs.

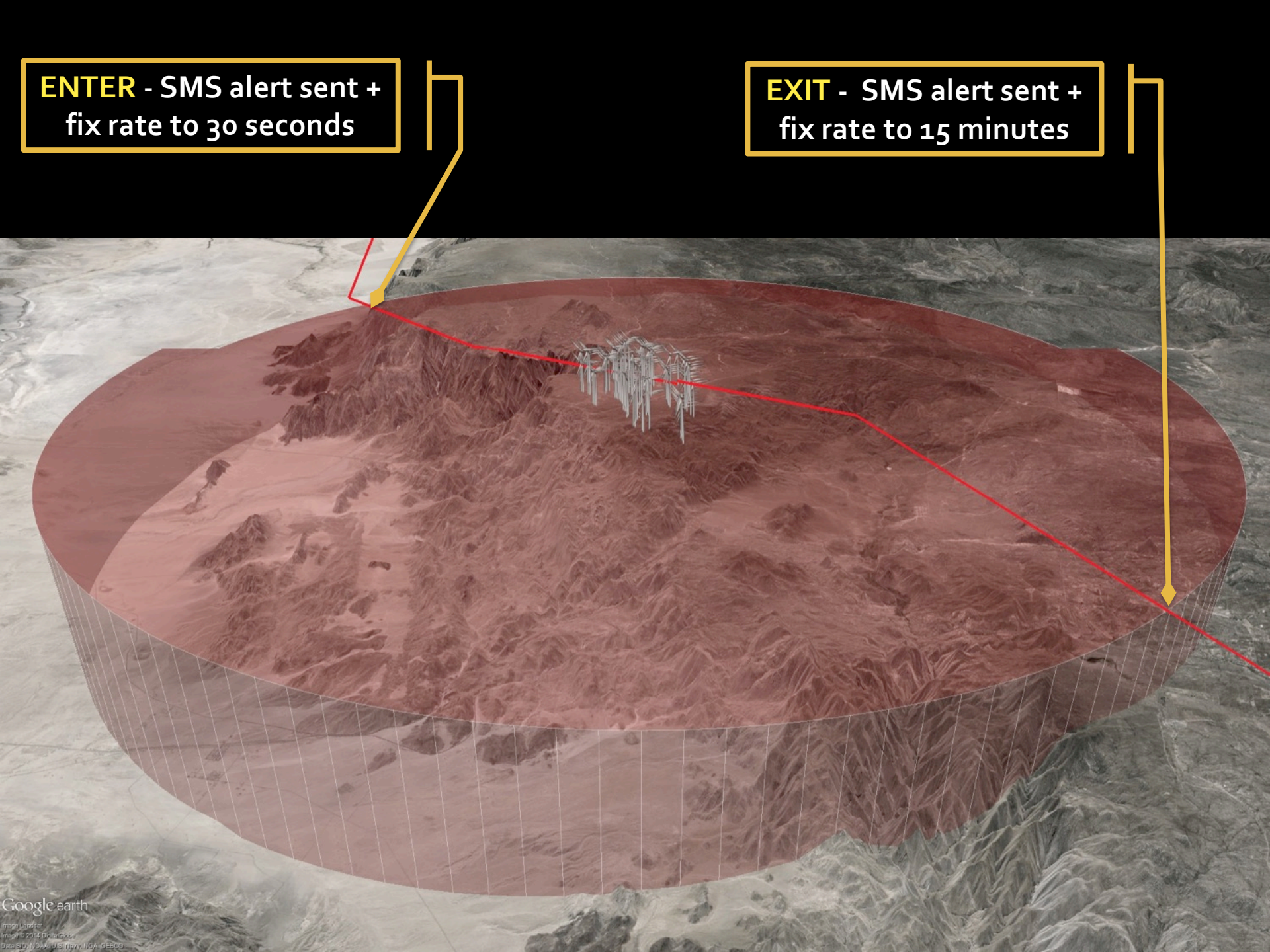
Raptor geofence alert system

- Firmware on the tags can be updated remotely while the units are deployed, e.g. new geofences.
- Location data is accessed via download from a secure webpage.
- Alert user list can be customized.

Raptor geofence alert system




117°10'W
117°0'W
116°50'W
116°40'W
116°30'W
116°20'W
116°10'W
116°0'W
115°50'W
115°40'W
33°0'N
32°50'N
32°40'N
32°30'N
32°20'N
32°10'N
32°0'N
N
San Diego
Tijuana
Tecate
Potrero
Rosarito
San Luis
Lakeside
Santee
Alpine
Pine Valley
Guatay
Winter Gardens
Casa de Oro
La Presa
Bonita
Chula Vista
San Ysidro
Five Points
Mission Hills
La Jolla
Del Mar
Solana Beach
Rancho Santa Fe
Miramar
Mcas Miramar
Capitan Grande Indian Reservation
Cuyamaca Rancho State Park
Cleveland National Forest
Campo Indian Reservation
VALLECITO MOUNTAINS
Us Naval Reservation
Naval Air Facility El Centro Seeley
UNITED STATES
MEXICO
Condor flight path
Energía Sierra Juárez wind-energy project Phase-1
20km geofence alert zone
40km geofence alert zone
0
10
20
40
60
80
Km

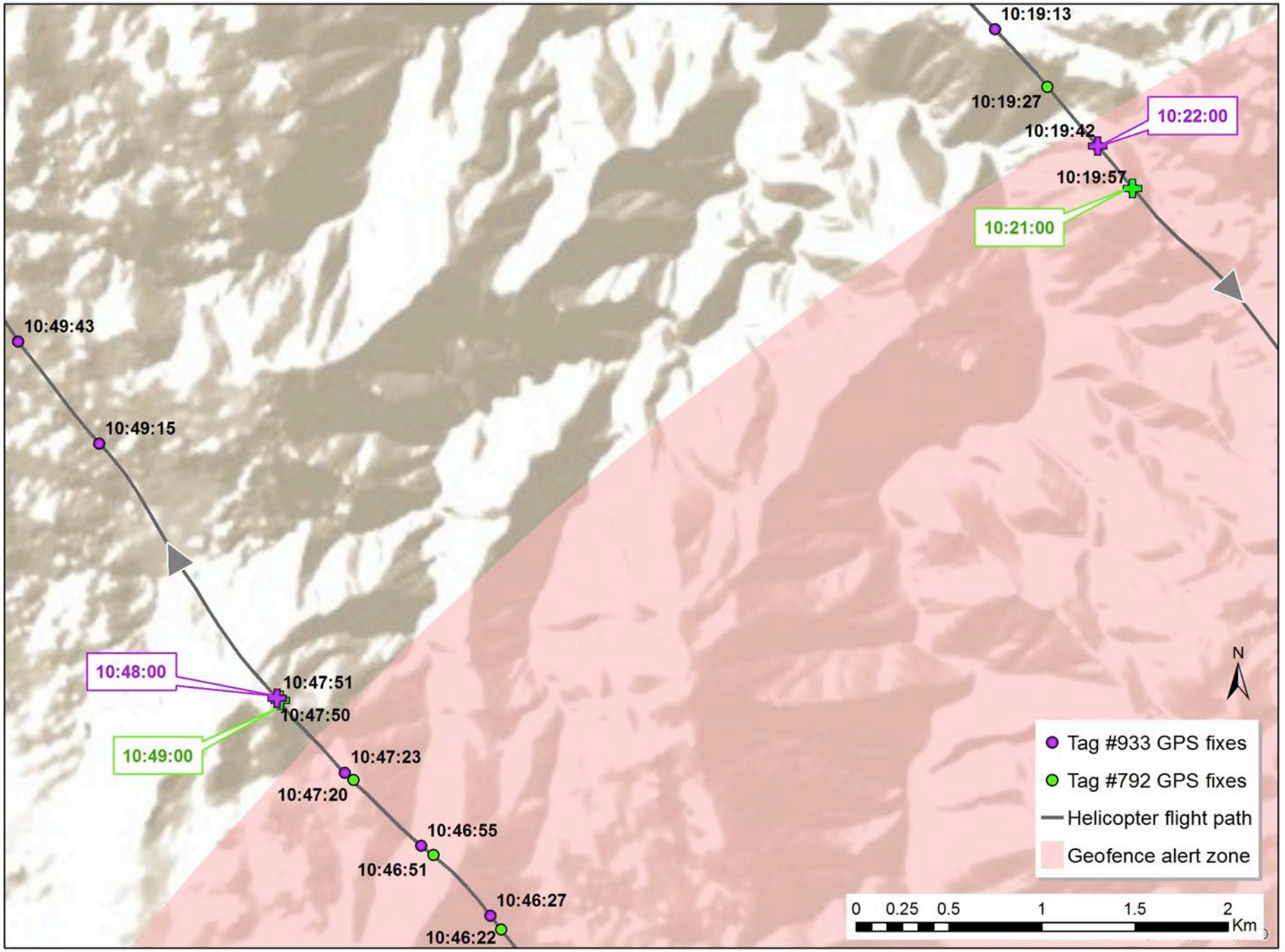

ENTER - SMS alert sent + fix rate to 30 seconds
EXIT - SMS alert sent + fix rate to 15 minutes
Google earth

Performance

- Field tests of geofence automated SMS alert message response times.
- Flew by helicopter along flight path of condor that crosses the ESJ wind farm.

Performance

- Location data highly accurate (<2m) tested against a sub-meter DGPS with GNSS driver.
- Average SMS response times after crossing geofence boundary: ~2 minutes.


10:19:13
10:19:27
10:19:42
10:22:00
10:19:57
10:21:00
10:49:43
10:49:15
10:48:00
10:47:51
10:47:50
10:49:00
10:47:23
10:47:20
10:46:55
10:46:51
10:46:27
10:46:22
N
Tag #933 GPS fixes
Tag #792 GPS fixes
Helicopter flight path
Geofence alert zone
0 0.25 0.5 1 1.5 2
Km

Limitations

- Birds must be captured and telemetered.
- Too heavy for smaller birds species + bats.
- Only operational during the day.
- Cost – currently $2,500/unit (plus data fees).
- What if tagged birds loiter..?
- How long would operators be willing to keep turbines shut down until a bird departs..?

Future directions

- More field testing, multi-species deployments, fine-tuning and adaptive management.
- Integrate geofence system into automated shutdown system.
- Integrate geofence system into deterrent system.

Take Home Message

Combining:

- GPS level accuracy
- High location fix sampling rates
- Location data received in near real time
- Automated SMS alerts

into an integrated and flexible geofence biotelemetry system will provide sufficient warning and time to implement appropriate mitigative actions to curtail avian wind farm collisions.

ACKNOWLEDGEMENTS

- Bailey Wildlife Foundation
- Ellen Browning Scripps Foundation
- Marisla Foundation
- Sempra Energy
- United States Fish & Wildlife Service (USFWS)
- Instituto Nacional de Ecologia (INE)
- Comision Nacional Para El Conocimiento y Uso de la Biodiversidad (CONABIO)
- Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT)
- Wildcoast/Costasalvaje

http://goo.gl/LgyCNQ