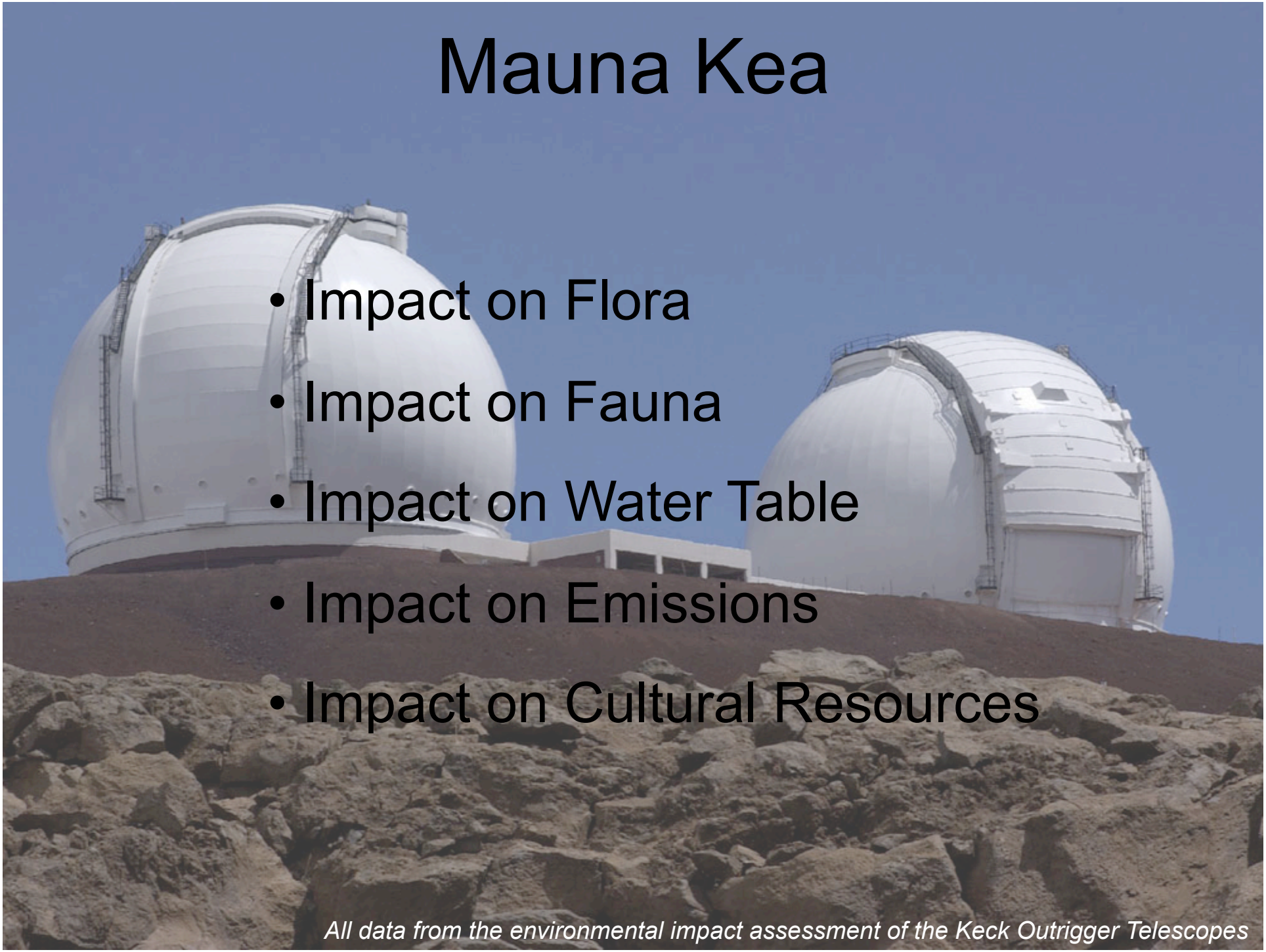
Environmental Ethics of Ground-Based Observatories

Mauna Kea



- Impact on Flora
- Impact on Fauna
- Impact on Water Table
- Impact on Emissions
- Impact on Cultural Resources

All data from the environmental impact assessment of the Keck Outrigger Telescopes

Mauna Kea - Impact on Flora

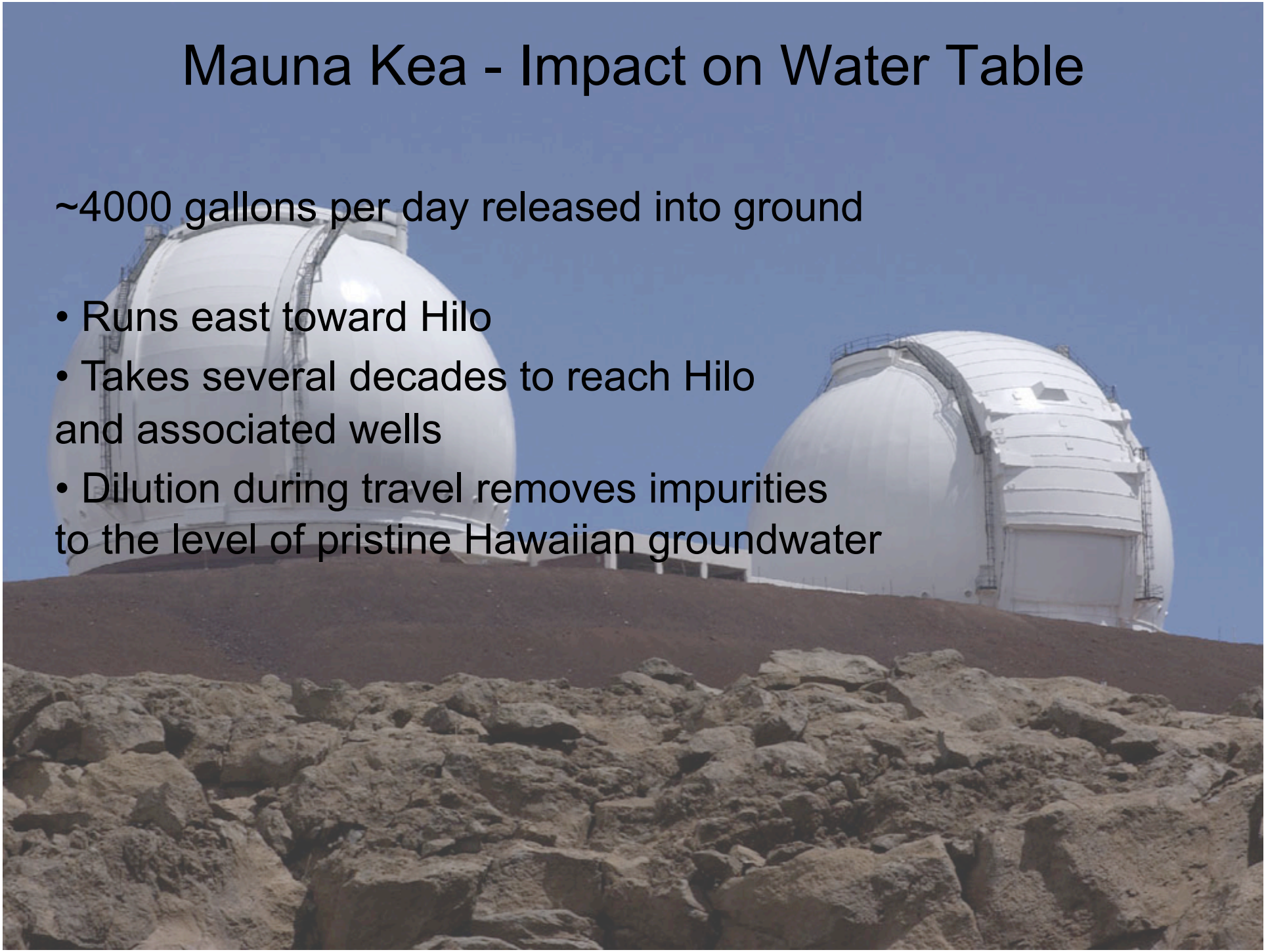
Mauna Kea - Impact on Fauna

1982-1998: Population decline by 99.7%
1998-2008: Evidence of resurgence

- Only habitat is Mauna Kea summit
- ~5% of habitat displaced by astronomy
- Prey for alien spider species introduced by increased human travel

Wekiu Bug, endangered

Mauna Kea - Impact on Water Table



~4000 gallons per day released into ground

- Runs east toward Hilo
- Takes several decades to reach Hilo and associated wells
- Dilution during travel removes impurities to the level of pristine Hawaiian groundwater

Mauna Kea - Impact on Emissions

900 observers /yr on major telescopes
Assume half are service mode
Assume all flights 2500 miles
~1 lb of greenhouse gases / flight mile

↓

500 metric tons of greenhouse gases / yr
(equivalent of 1100 average people / yr)

Mauna Kea - Impact on Cultural Resources

Traditional Use of Mauna Kea
- Lower slopes: gathering from forest
- Upper slopes: stone quarry
- Summit: worship / sacred landscape

• Presence of humans, technology, and waste water contaminate sacred area

• Alteration of cinder cones (most sacred) destroys alignment critical to religious rites

• Shrines intentionally / accidentally destroyed by non-native workers

Antarctica

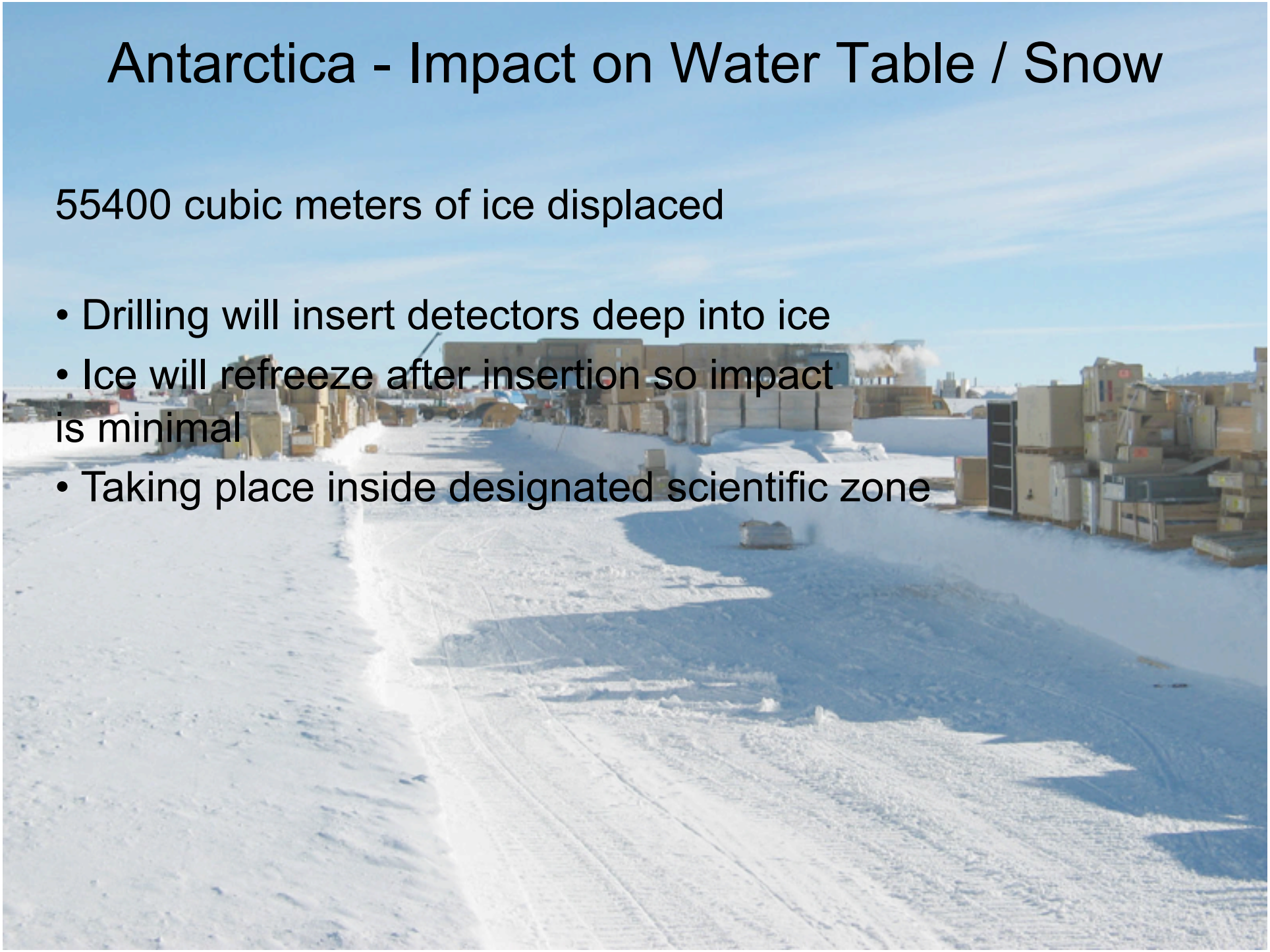
- Impact on Flora
- Impact on Fauna
- Impact on Water Table / Snow
- Impact on Emissions
- Impact on Cultural Resources

All data from the environmental evaluation of Ice Cube

Antarctica - Impact on Flora

Antarctica - Impact on Fauna

Antarctica - Impact on Water Table / Snow



55400 cubic meters of ice displaced

- Drilling will insert detectors deep into ice
- Ice will refreeze after insertion so impact is minimal
- Taking place inside designated scientific zone

Antarctica - Impact on Emissions

375 additional flights from USA
9000 miles/flight
~1 lb of greenhouse gases / flight mile

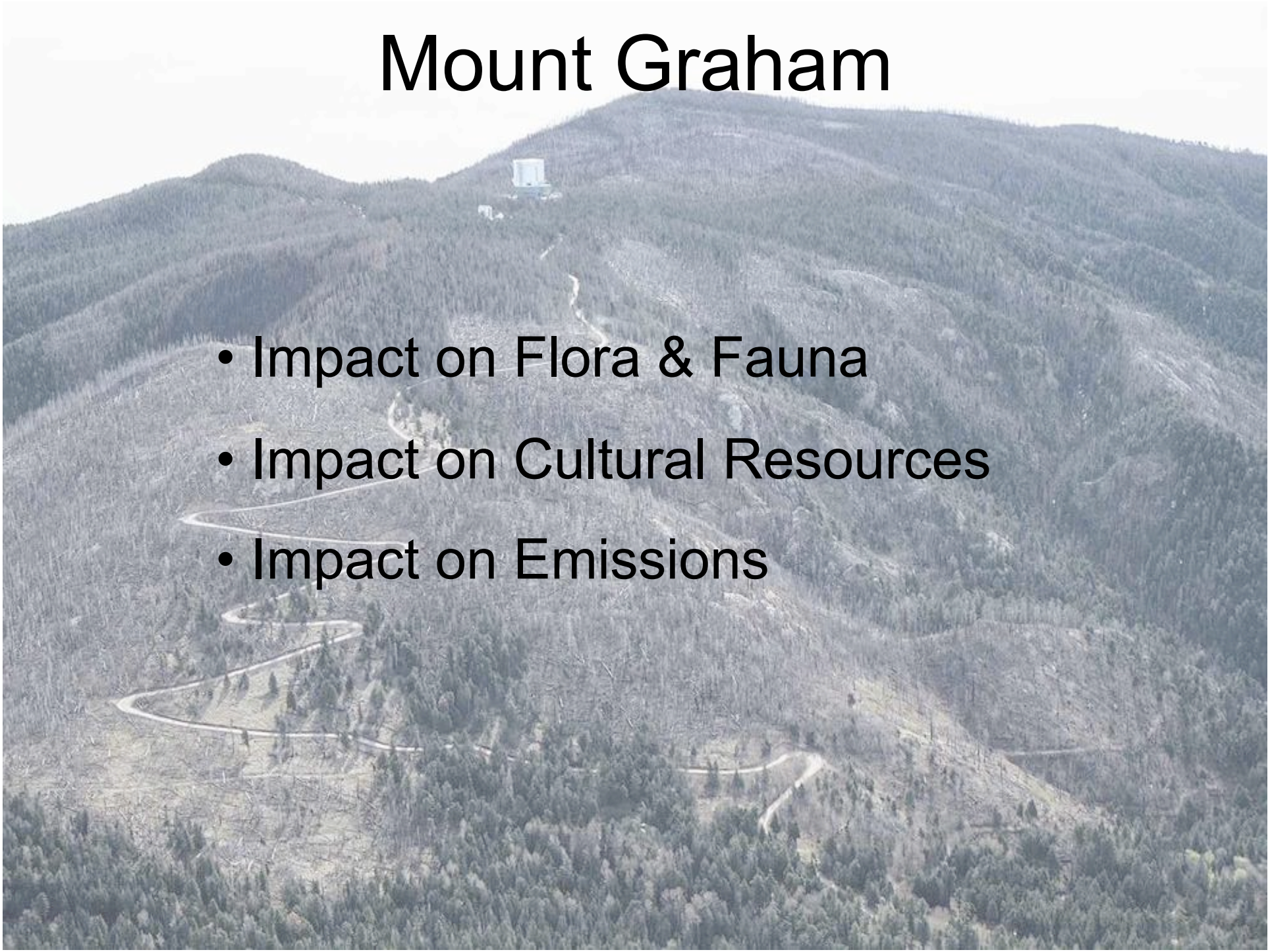
1500 metric tons of greenhouse gases
(equivalent of 408 average people for 8 yrs of operation)

PLUS: 10% CO increase, 80% sulfur oxides increase on the ground

Antarctica - Impact on Cultural Resources

Antarctica - Impact on Cultural Resources

Mount Graham

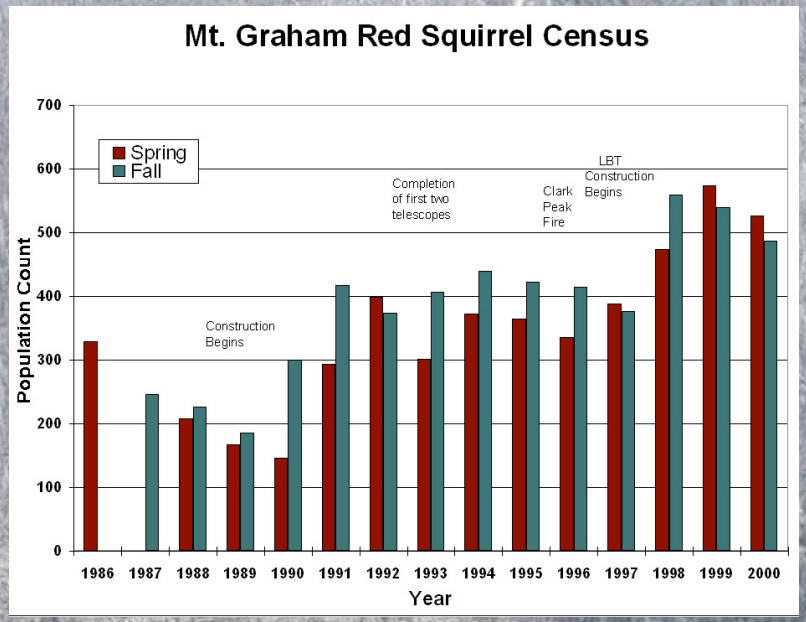


- Impact on Flora & Fauna
- Impact on Cultural Resources
- Impact on Emissions

Mount Graham - Impact on Flora & Fauna

Largest controversy (1980's-90's): Endangered red squirrel

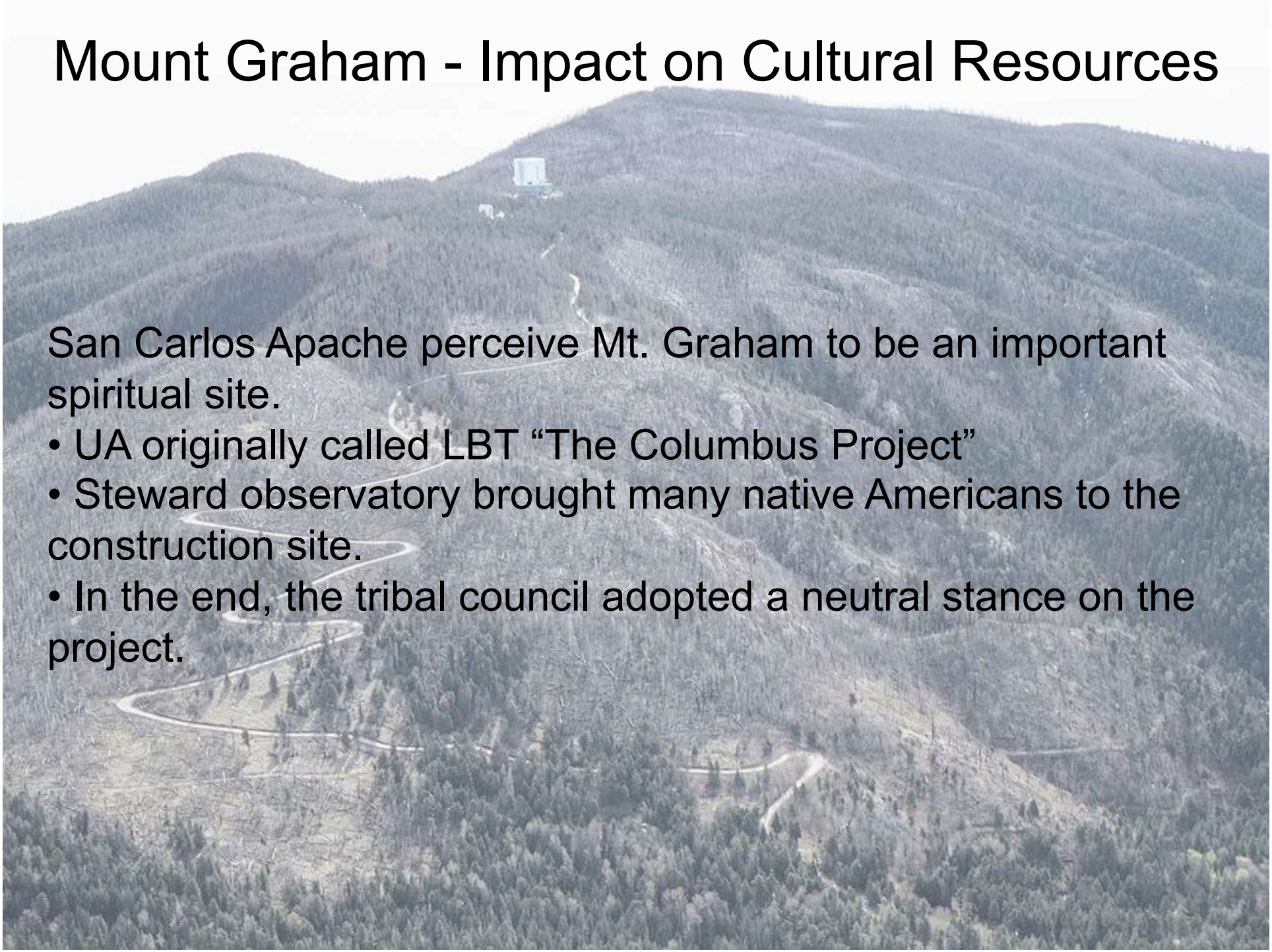
- Thought to be extinct in 1950's; Mount Wilson is only habitat
- Numerous protests, court battles, congressional lobbying, etc.



Credit: http://medusa.as.arizona.edu

Credit: Paul Young

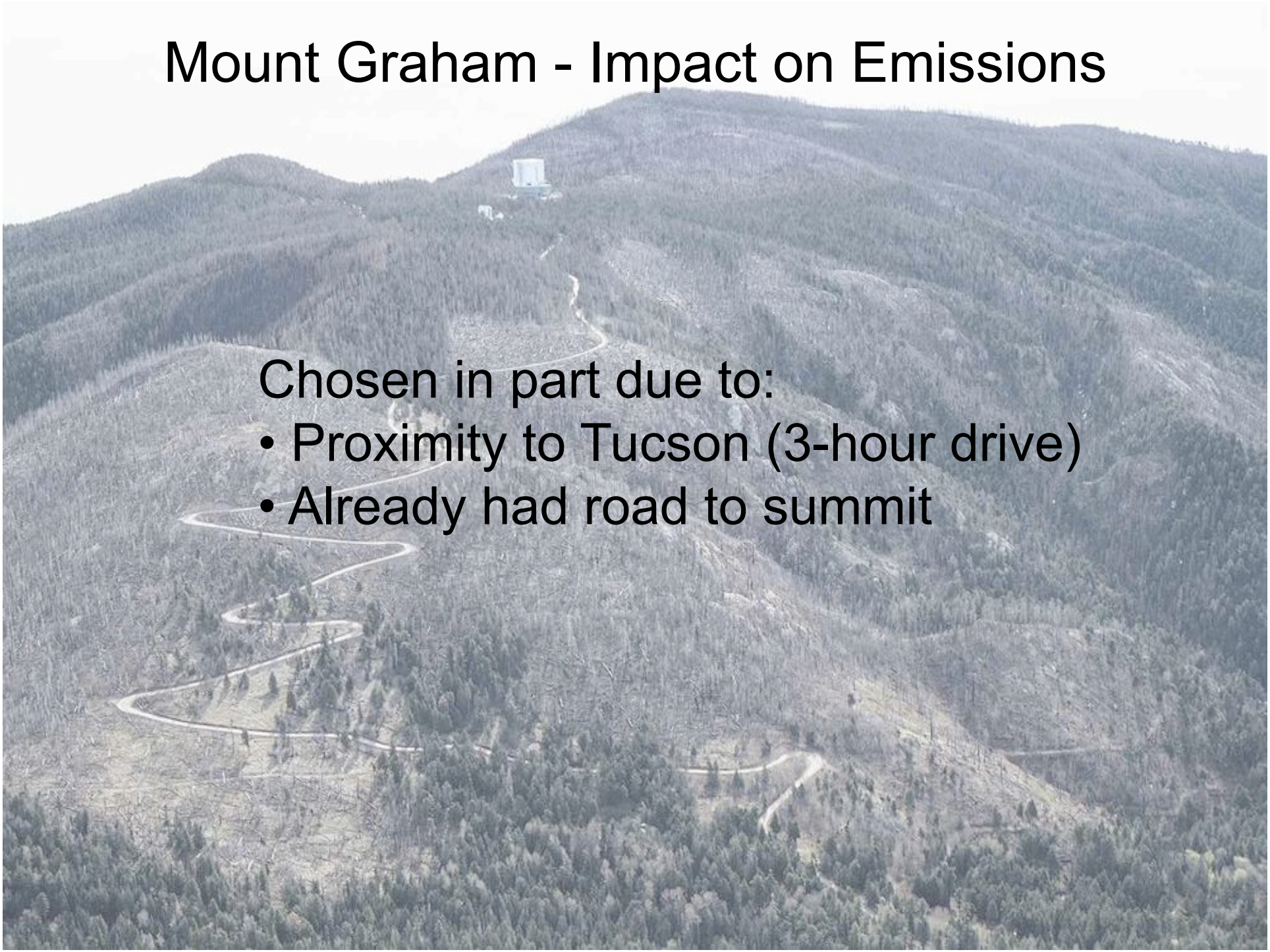
Mount Graham - Impact on Cultural Resources



San Carlos Apache perceive Mt. Graham to be an important spiritual site.

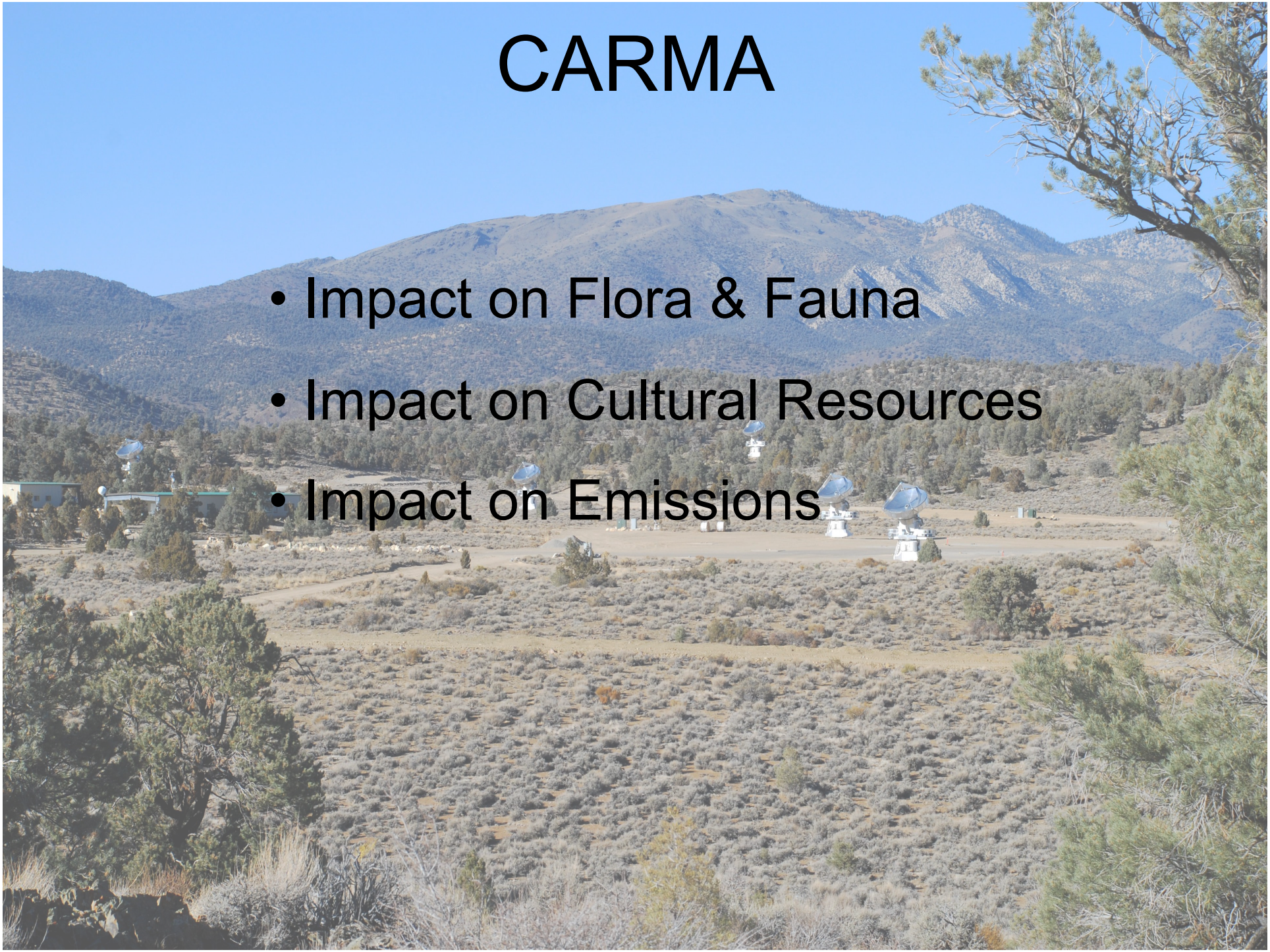
- UA originally called LBT “The Columbus Project”
- Steward observatory brought many native Americans to the construction site.
- In the end, the tribal council adopted a neutral stance on the project.

Mount Graham - Impact on Emissions



Chosen in part due to:

- Proximity to Tucson (3-hour drive)
- Already had road to summit


CARMA
• Impact on Flora & Fauna
• Impact on Cultural Resources
• Impact on Emissions

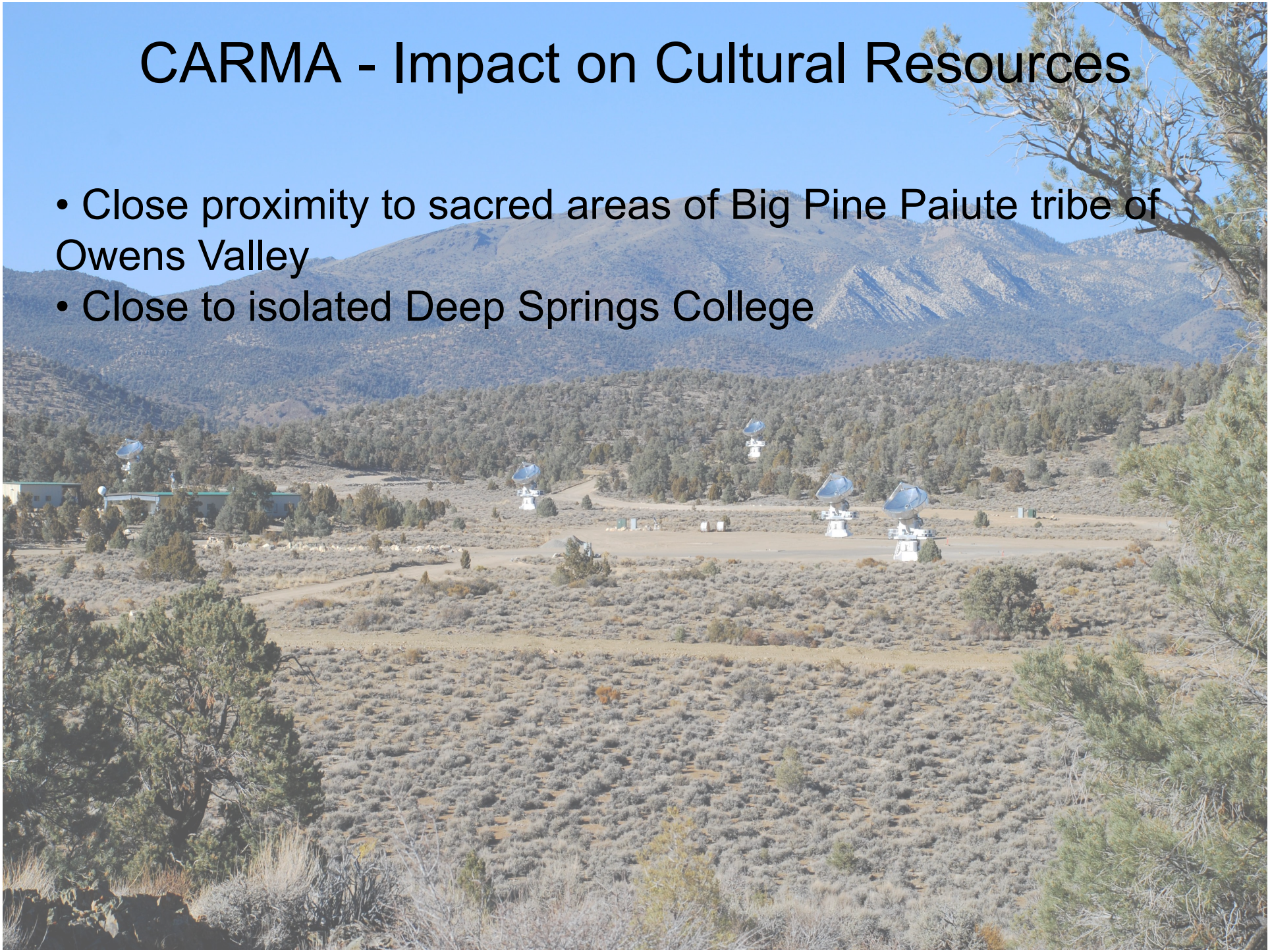
CARMA - Impact on Flora & Fauna

Credit: wikipedia.org

Largest controversy: California Native Plants Society

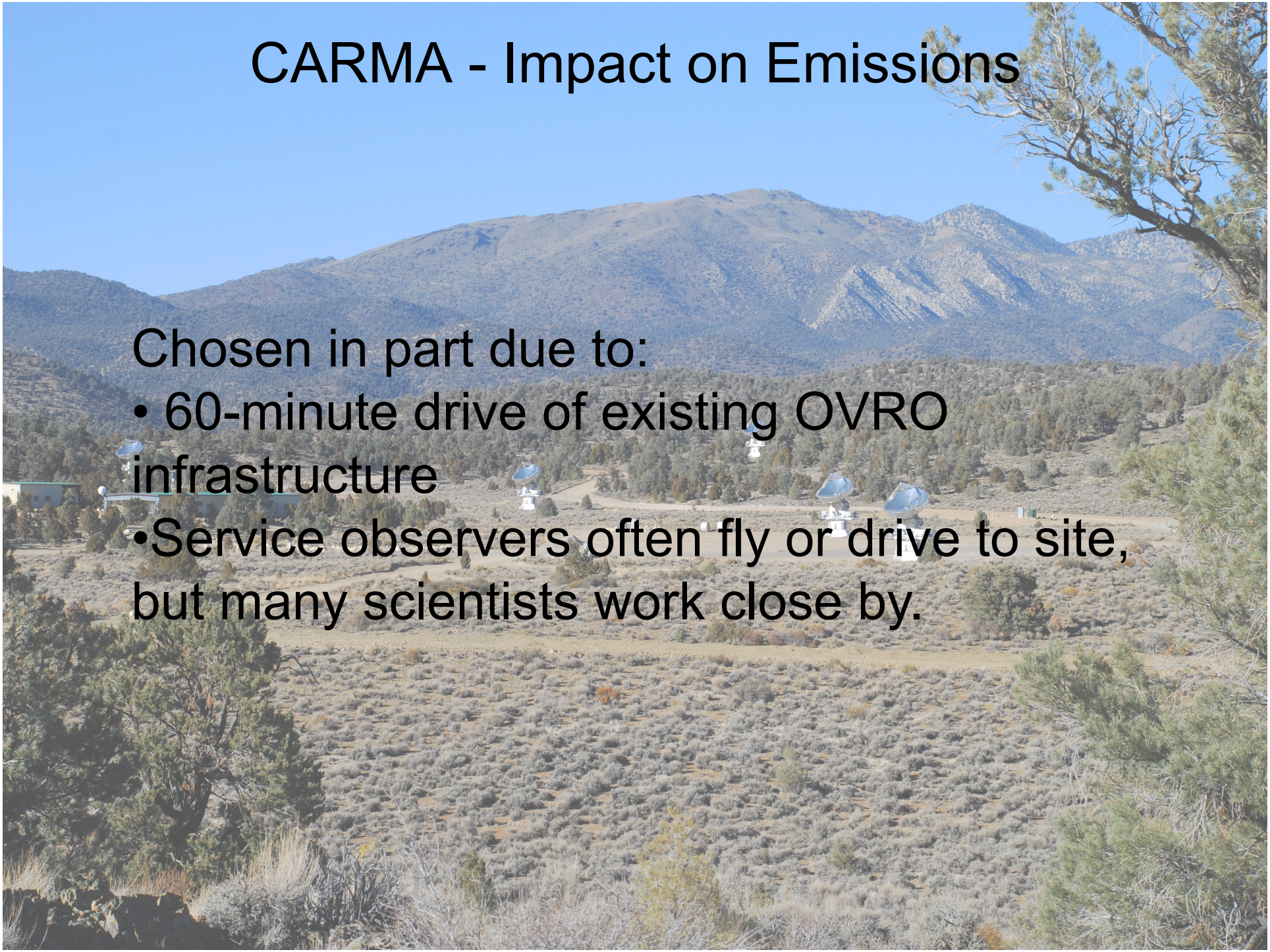
- Unique ecosystem (e.g. close to famous Bristlecone forest)
- "Undisturbed" sites originally proposed
- "Best" astronomical site not chosen

CARMA - Impact on Cultural Resources



- Close proximity to sacred areas of Big Pine Paiute tribe of Owens Valley
- Close to isolated Deep Springs College

CARMA - Impact on Emissions



Chosen in part due to:

- 60-minute drive of existing OVRO infrastructure
- Service observers often fly or drive to site, but many scientists work close by.

Scientific Returns per Carbon Footprint

	Publications (P) *(per yr from 2003)*	*Citations (C)* *(of papers from 2003)*	*Emissions (E)* *(Avg Person's CO_2/yr)*	*E/P*	*E/C*
Mauna Kea	325	6150	1100	3.4	0.2
Antarctica	N/A	N/A	400	N/A	N/A
Steward	8	128	~75	9.4	0.6
CARMA	34	460	~95	2.8	0.2

Publication and citation data from Trimble & Ceja 2008;
CARMA data for 2003 is the sum of OVRO and BIMA:
Emission calculated based on avg. # observers, avg travel time and mode, and on-line carbon footprint calculators