



**NOAA
FISHERIES**

UAS can augment and improve aerial surveys of pinnipeds, but what about disturbance?

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Tested UAS Platforms

Steller Sea Lion Surveys



Puma
Fixed-wing



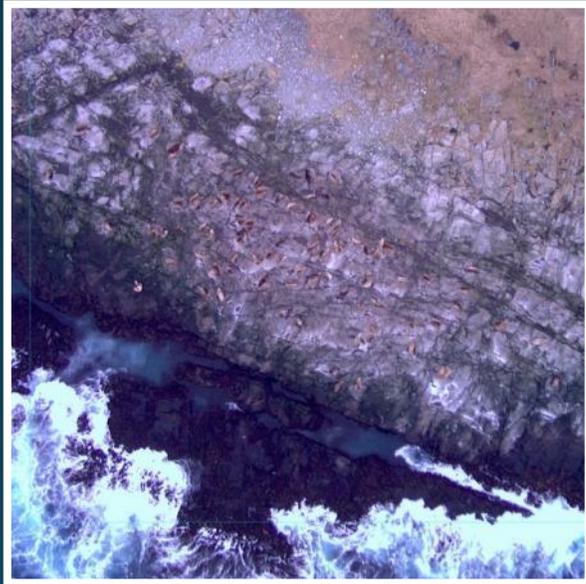
Aeryon Scout
Quadcopter



APH-22
Hexacopter

Tested UAS Platforms

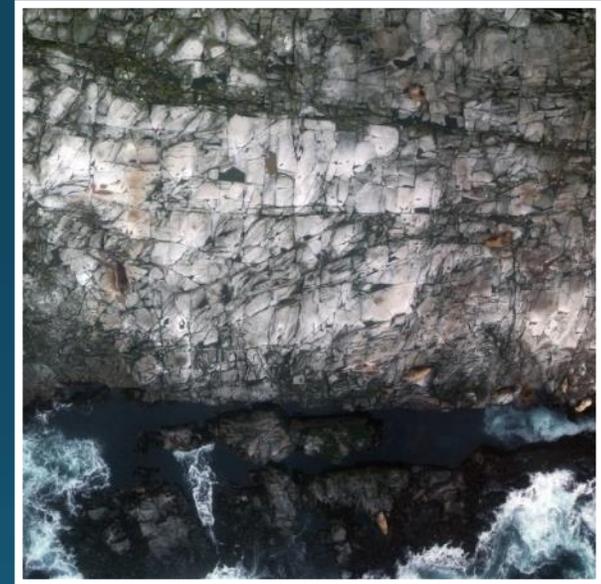
Image Comparision



Puma
Fixed-wing



Aeryon Scout
Quadrocopter



APH-22
Hexacopter



APH-22 Hexacopter

Compared to Occupied Aircraft Survey Images



Twin
Otter



APH-22
Hexacopter

APH-22 Hexacopter

Aerial Imaging Solutions



Six-motor rotor-craft

Payload allowance ~1 lb

- Canon EOS M (18mp)
- 1 to 1.5 cm/px resolution

Hovering capabilities

GCS with 'live view'

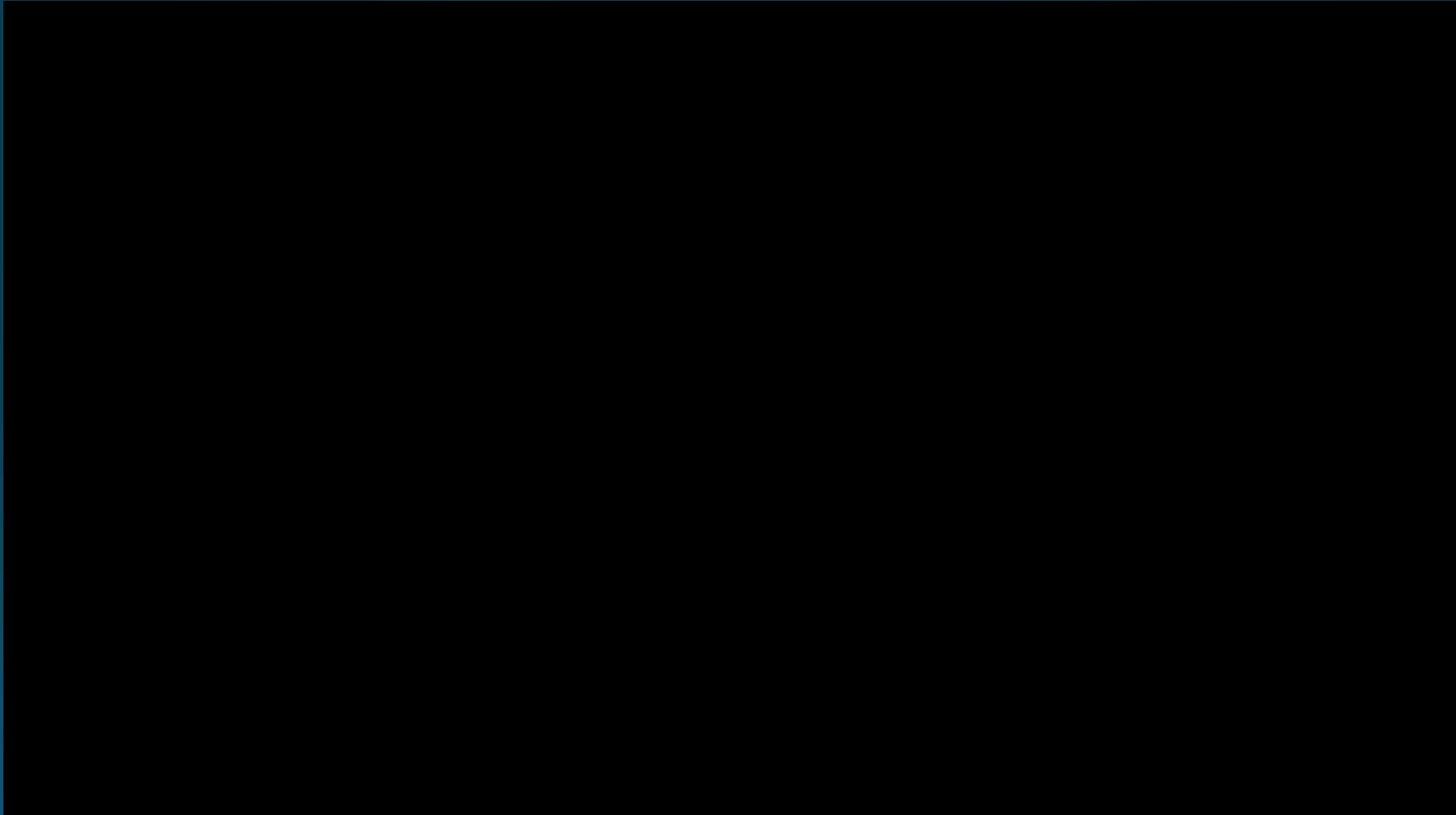
Safety and reliability

Waypoint capabilities



Hex Operations

Calibrations and Flight Procedures





Abundance Surveys

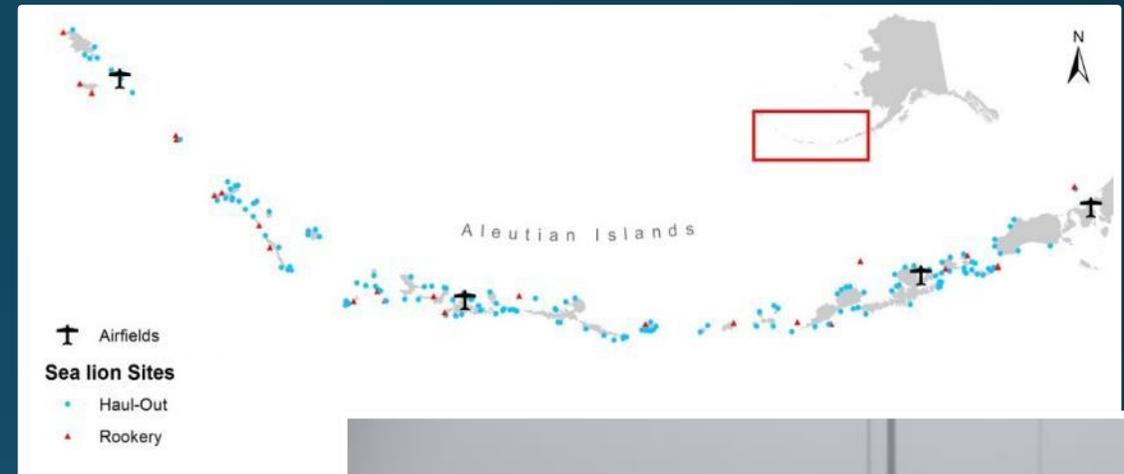
Steller Sea Lions



Challenges with Twin Otter

- Remote and scarce airfields
- Inclement weather
- Site topography
- Cost vs. accomplishments
 - 2012 survey
 - Pribilof Islands
 - Wa/Ca/Or SSL surveys

Solution: UAS piloted by in-house biologists



APH-22 Hexacopter

Alaska Ecosystem Program



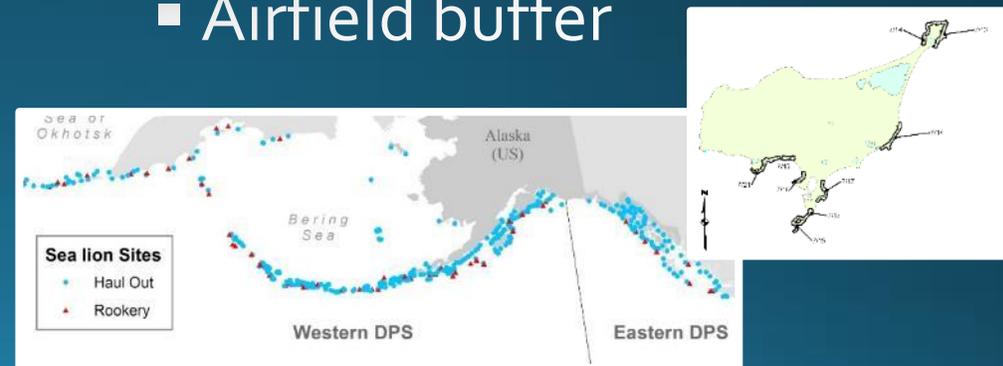
Pros:

- Portable
- Survey in remote locations
- Flown by in-house biologists
- Fly from ship, small boat, or land
- Survey more often in patchy weather
- High-resolution images
- Hovering capabilities



Cons:

- Reduced efficiency over large geographic area
 - UAS will not replace Twin Otter, only augment
- Wind limitations
- Class E wx mins (FAA regs)
- Airfield buffer



Abundance Surveys

2014

- Most complete survey since the 1970s
- Sweeney, et al. 2016. *J. of Unmanned Vehicle Systems*

2015

- Visited sites the Twin Otter missed in 2014 (n=4)
- Used APH-22 to survey Pribilof Island sites (n=6)

2016

- Most complete survey W of Delarof Islands (missed 7 sites)
- Twin Otter team missed 26 sites

2017

- Visit sites missed by Twin Otter in 2016

Marked Individuals

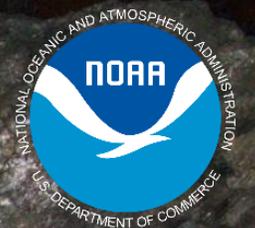
Steller Sea Lions

Traditional method

- Observers from skiff or shore
- Challenges
 - Site topography
 - Large aggregation of animals

Hexacopter images

- Seeing twice as many brands
- Challenge: Left sides must be showing



Marked Individuals

Steller Sea Lions



=297 Brand

Pribilof Islands

Aerial Surveys

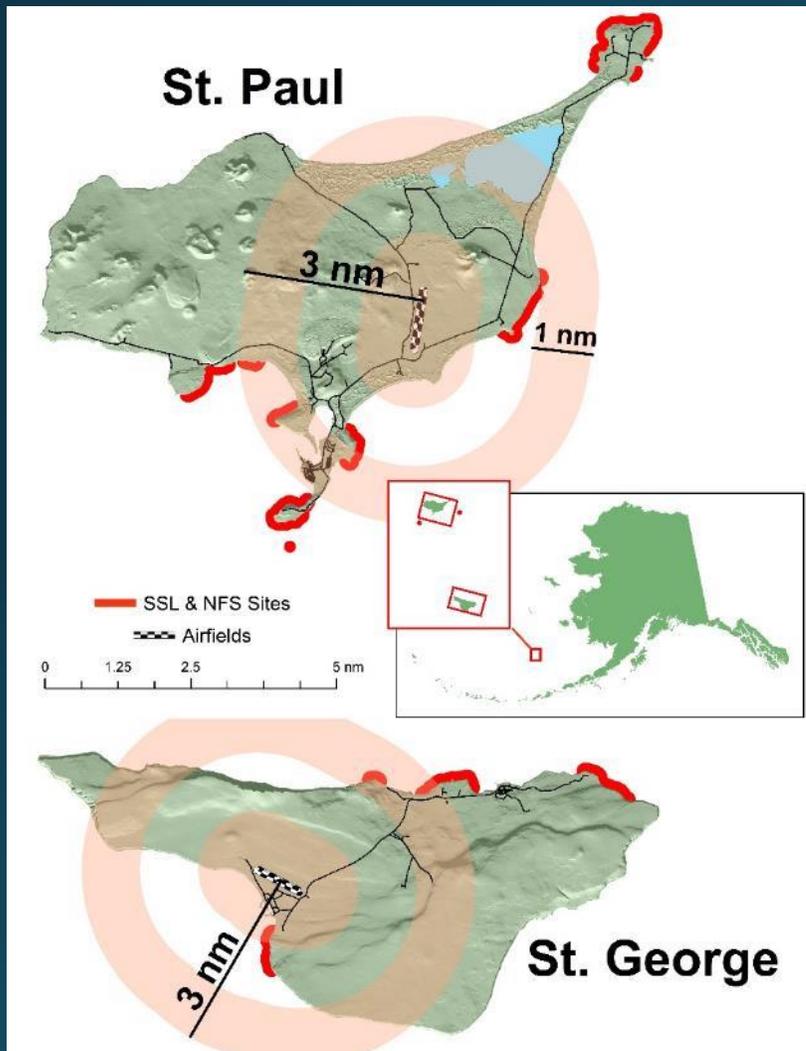
Many Twin Otter attempts unsuccessful
Important area for two protected species

- Endangered Steller sea lion
- Northern fur seal ('depleted' under MMPA)

UAS is the only viable option

Challenges:

- Airfields
 - New rule: 3nm buffer?
 - Flights are rare
 - Coordination is entirely feasible



Rookery Mapping

Northern Fur Seals

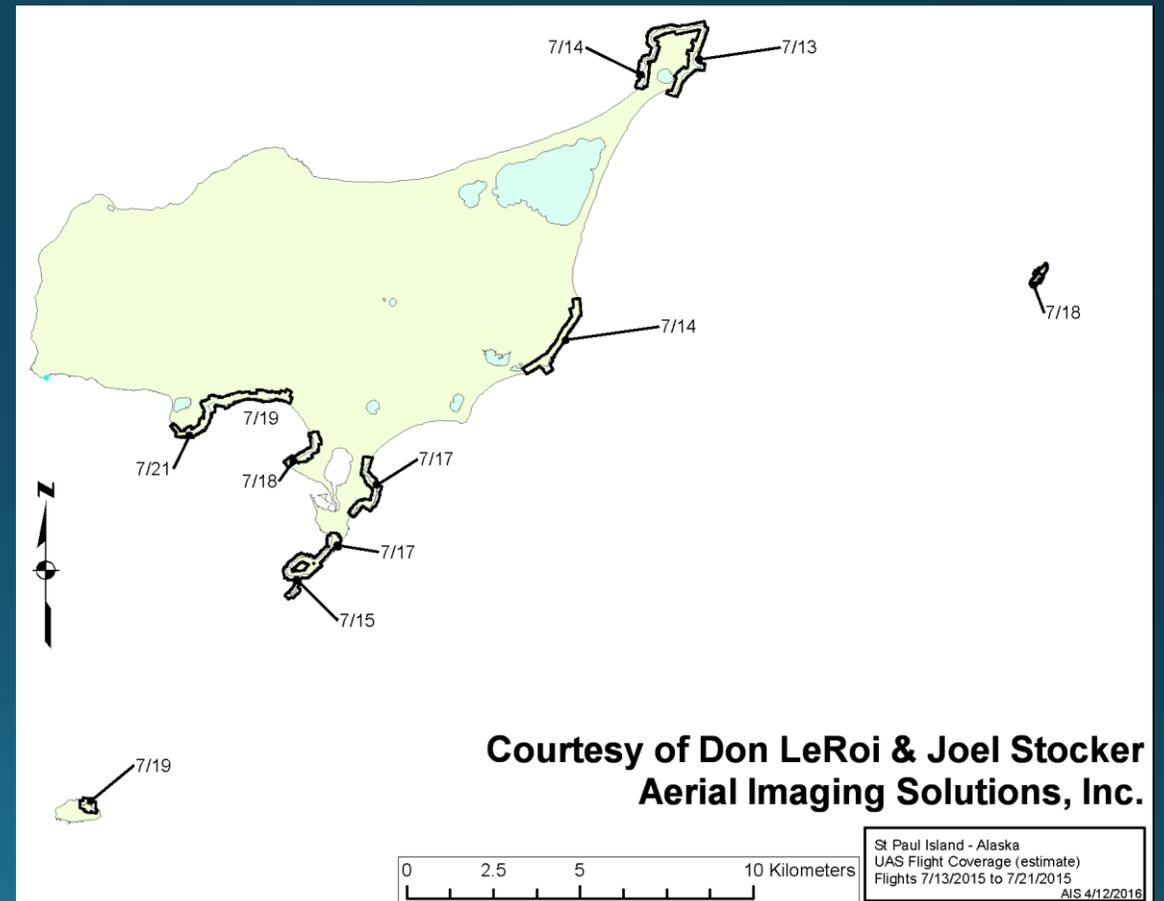


Historical rookery space-use

- 1948, 1967, 1988

Successfully completed in 2015
(7 years overdue)

- 14 mi coastline, up to 1,000 ft inland
- 7 survey days, 2 weather-down days
- 60 flights, 10 hours, 17 sites





Waypoints by Flight

- | | |
|-----|-----|
| ● 1 | ● 5 |
| ● 2 | ● 6 |
| ● 3 | ● 7 |
| ● 4 | ● 8 |

Southeastern Island Pearl & Hermes Atoll

High easterly winds aloft
Altitude 122 m (400 ft)
High (~60%) overlap for 3D

8 flights total in 2 hours
Area of red outline: 0.22 km2
53.3 Acres
0.08 mi2

Courtesy of Don LeRoi & Joel Stocker
Aerial Imaging Solutions

0 125 250 500 Meters

Abundance Assessments?

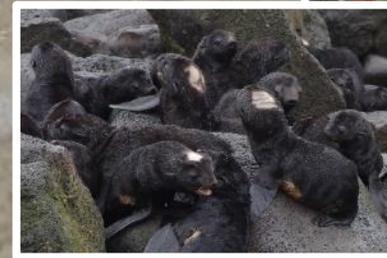
Northern Fur Seals

Current method: Pup Shear Sampling

- Requires ~20 people
- High cost (delays in ANC common)
- Three weeks
- **Disturbance of all sites**

Proposed method: UAS Aerial Surveys

- Hex team: 2 biologists/PICs
- Ten days, no disturbance (100 ft altitude)
- Challenges:
 - Weather (wind, fog/low ceilings): gimbal mount
 - **Need access to rookeries near airfields!**



Disturbance Assessment

UAS Emerging into the Mainstream



TOURIST OPERATED UAS IN RUSSIA

Disturbance Assessment

2014 – Permitted survey altitudes



Hexacopter: 0.3% (150-200 ft. altitude)

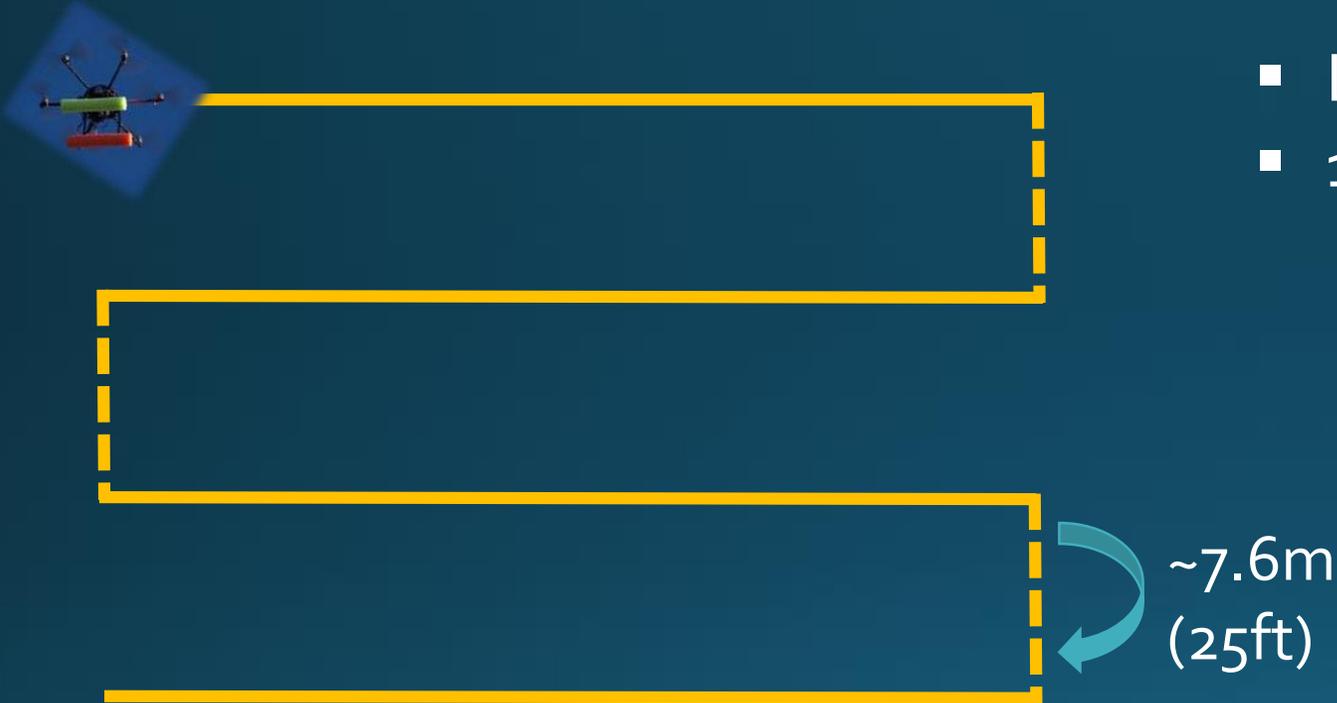
Twin Otter: 5% (~750 ft. altitude)

Assessing Disturbance



APH-22 Surveys

- Locate study group of 30-50 individuals
- 1-2 observers on the ground
 - Record behavior and video



DISTURBANCE STUDY DATA SHEET											
SITE: <i>site name</i>		DATE/TIME: <i>date/focal time</i>			SPECIES: <i>list target study species</i>						
WIND: <i>wind speed/direction</i>		TEMP: <i>temperature</i>			SITE TYPE: <i>describe site (i.e., base of cliff X m high, animals in tight clusters)</i>						
# ANIMALS: <i>approx # of animals in observed group</i>		BEHAVIOR: <i>are they awake/moving around? Sleeping?</i>			BEACH DROP: <i>describe water entry (i.e., sloping gravel beach, or 3m drop off from rock)</i>						
PASS #: <i>is this the first hex pass?</i>		TIME: <i>approx time of each pass</i>			ALTITUDE: <i>approx altitude of pass (discussed prior)</i>						
NO RXN	LOOK UP	CHANGE POSTURE	CHANGE POSITION	MOVE <3m	MOVE >3m	TO WATER (TIDAL)	TO WATER (SWIM)	STAMPEDE	OTHER		
<i>did not react</i>	<i>only looked up</i>	<i>stood up</i>	<i>moved around pos</i>			<i>moved to water</i>	<i>entered water</i>	<i>number of stampede</i>	<i>other behavior?</i>		
PASS #:		TIME:			ALTITUDE:						
NO RXN	LOOK UP	CHANGE POSTURE	CHANGE POSITION	MOVE <3m	MOVE >3m	TO WATER (TIDAL)	TO WATER (SWIM)	STAMPEDE	OTHER		
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COMMENTS: <i>additional comments? Summary of reactions? Did it seem like animals were aware of us before we flew? Did they react at any hex movement in particular (quick alt or forward adjustment)?</i>											



- Vertical transect lines
- Hexacopter lowered away from group

Assessing Disturbance

APH-22 Surveys



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SITE: sitename		DATE/TIME: date/local time			SPECIES: list target study species						
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PASS #:		TIME:			ALTITUDE:						

Many influencing factors

- Site type (rookery vs. haul-out)
- Season (winter vs. breeding season)
- Weather (wind and rain)
- Ambient noise (wind, surf, animals)
- Site topography (cliff or flat island or beach)
- Cumulative effect?

Need a large number of surveys in various conditions

San Miguel Island (California)?

- Up to 5 pinniped species
- Two seasons (February and July)



Assessing Disturbance

Steller Sea Lions at East Cape Haulout, Amchitka Island



Assessing Disturbance

Northern Fur Seals at Vostochni Rookery, St. Paul Island



Moving Forward . . .

Small UAS Surveys



Regulations:

- Class E wx minimums
 - 3nm vis/500ft below ceiling
 - Class G wx mins?
- PIC Training
 - Class II Medical, ground school, private pilot exam
- Airfield buffer
 - Waiver/special provisions?
 - Training instead of PPL?

Technology:

- Vertical images in high winds
 - Gimbal mount
- Altitude reading vs. elevation
 - Laser altimeter
- Geo-referenced images
 - Versus post-processing

Thank You!

Many thanks to all involved in the success of these projects

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