



Conservation & Regulation

➤ The Conservation Paradigm

1. Avoid "Take"
2. Minimize Take
3. Mitigate for Take

➤ IdentiFlight Value Propositions—where we're going

- Provide solutions for the avoidance and minimization of take
- Development Stage: Superior estimates of eagle risk
 - Reduce up-front mitigation costs
 - IdentiFlight as Experimental ACP in ECP
- Operating Projects: Reduce or eliminate eagle take
 - IdentiFlight as part of informed curtailment program
 - Reduce impact of Adaptive Management (eliminate A.M.)
 - Reduce mitigation costs triggered by take (eliminate take)
- Accepted as Experimental ACP in Eagle Take Permit Application



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What Has Eagle Prosecution Cost?



DUKE:

- ✓ Take of 14 Eagles and 149 protected birds led to prosecution at 4 windfarms in WY
- ✓ \$1 Million fines and restitution
- ✓ \$600,000 per year cost cap for implementing Migratory Bird Compliance Plan during 5 year probation period
- ✓ Mitigation costs for any eagle take that occurs

PACIFICORP:

- ✓ Take of 38 Eagles and 336 protected birds led to prosecution at 2 windfarms in WY
- ✓ \$2.5 Million fines and restitution
- ✓ \$600,000 per year cost cap for implementing Migratory Bird Compliance Plan during 5 year probation period
- ✓ Mitigation costs for any eagle take that occurs

OTHERS:

- ✓ USFWS is investigating 17 cases
- ✓ 7 enforcement matters have already been referred by USFWS to DOJ for possible prosecution

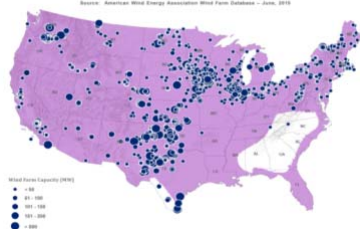


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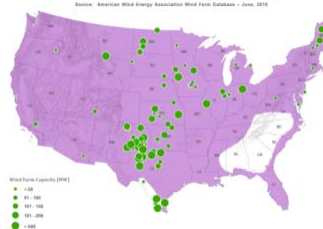
Where are there eagle problems?



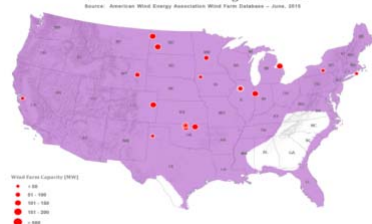
Wind Farms Operating in the United States
With Bald & Golden Eagle Habitat



Wind Farms Under Construction in the United States
With Bald & Golden Eagle Habitat



Wind Farms Under Development in the United States
With Bald & Golden Eagle Habitat



While some projects will have higher risk than others, almost all wind energy projects have some potential to take either a Bald or Golden Eagle.



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Camera System Setup



Two stereoscopic high resolution cameras on a pan-tilt unit move to focus on objects being tracked.

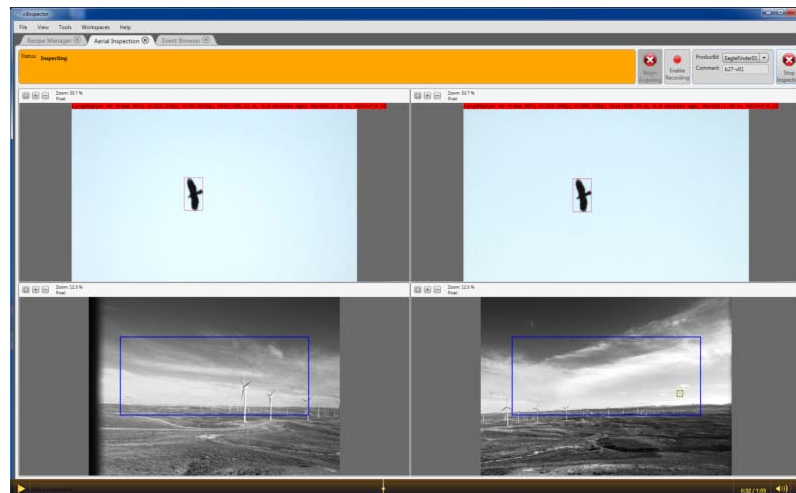
Two (for 120 degree view) fixed Wide Field of View (WFOV) cameras pick up moving objects to track.

360 degree view package



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Aerial Inspection Screen Shot

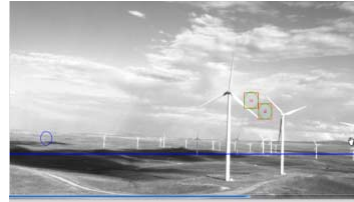


Views from 2 WFOV cameras (lower) and 2 High Res cameras (upper).



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Eagles at Play: Caught In Action By IdentiFlight



Like risk taking teenagers, these two eagles played for several minutes with an operating wind turbine T13 at 6:13 p.m. Saturday July 18, 2015.

Fortunately, they're unharmed.

There was no human observer on station at that time.



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Stereo Vision - Key to Determining Distance and Size



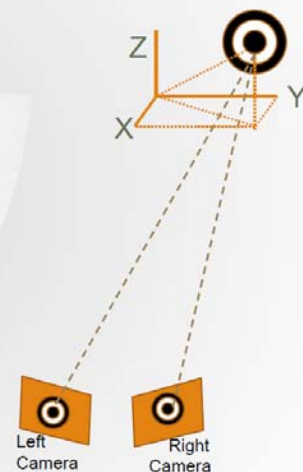
Calibration results for high resolution sensors

Reference Distance* [m]	Average [Error] [m]	Worst Error [m]	Worst Error %
677	11.54	-18.55	-2.7 %
894	13.88	25.80	2.9 %
1,104	20.53	41.06	3.7 %

* Reference distance is a nearby turbine used for repeated measurements. The actual distance to the turbine was determined with a laser range finder.

What does this mean?

Wingspan is proportional to the distance from camera:
 $3.7\% \text{ of } 77'' = 2.85''$



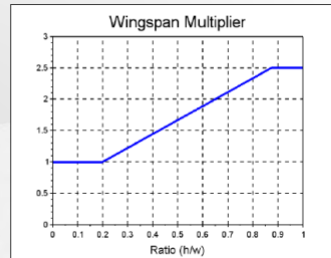
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Estimating Size From Oblique Flight Pattern



Estimate wingspan

- A simple heuristic method is currently used to estimate wingspan of flapping birds or birds oriented at various angles to the optical system
- Pose-estimation will provide more accurate estimates (pending implementation).
- 92% of golden eagles were classified as large raptors based on measured wingspan alone.



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Classification - Other Discriminating Factors



Color:

Red head of turkey vulture.

Shape:

Tail and head size

Wing shape differences between eagle and vulture.

Colors by zone:

Analysis of five body zones enables discrimination, for example of the banding of juvenile eagle tail

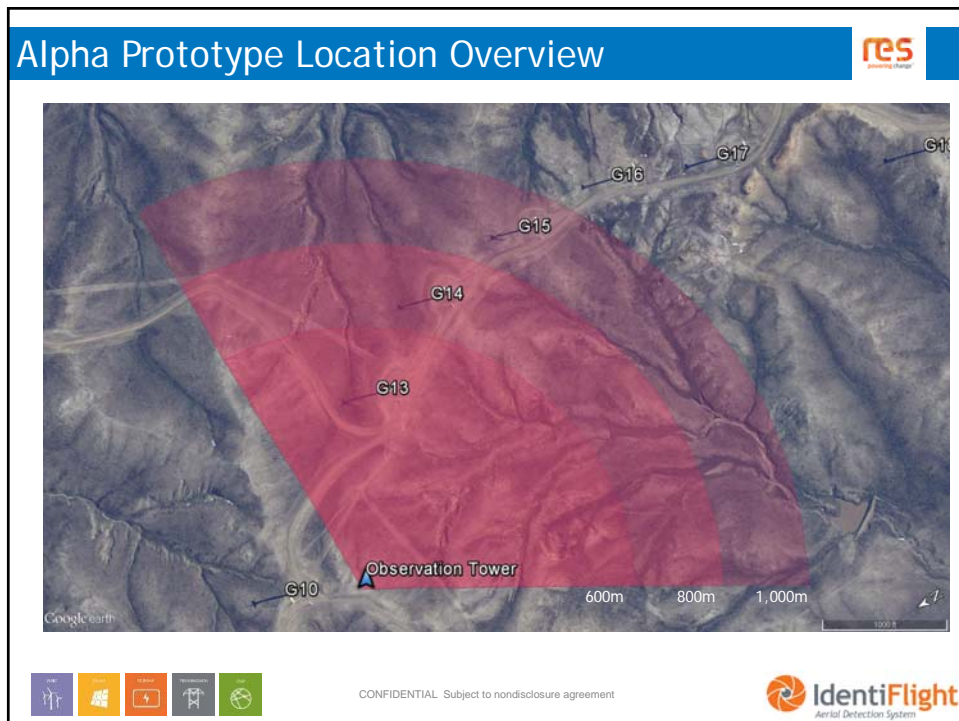
Behavior: in glide or flapping

In each picture frame (3 to 5 per second) machine vision software analyzes eighty attributes enabling real time classification decisions.



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Alpha System Data Collection - Goals & Metrics



Goals:

- Collect a significant training dataset of eagle images for identification and classification algorithm refinement
- Test and refine pan & tilt predictive tracking algorithms
- Test and refine stereo vision distance measurements
- Test the Alpha System design in extreme climatic conditions

Metrics:

- 8 month data collection campaign (March - October, 2015)
- 120° visual coverage using prototype Alpha System
- 1,000 meter targeted eagle observation range
- 9m AGL at Duke Energy's *Top of the World Wind Farm* eagle observation tower



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The IdentiFlight Tower



Minimal disruption of existing windfarm infrastructure.

- ✓ Camera systems mounted on standalone towers.
- ✓ Tilt-up towers are ballast weighted causing minimal ground disturbance and relocateable if needed.
- ✓ Signals transmitted around the windfarm by wireless, eliminating need to install fiber.
- ✓ Remote power systems



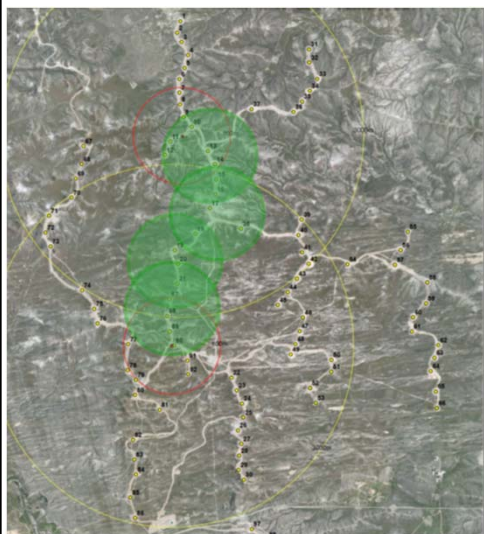
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The IdentiFlight Tower - Beta System



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Top of the World Beta Test



Four Systems Installed February 2016
Siting along turbine string with high eagle activity

- Green circles 800m diameter on IdentiFlight tower location
- Conservative and varying overlap (relative to ultimate commercial objective) to optimize statistical analysis of individual and system performance

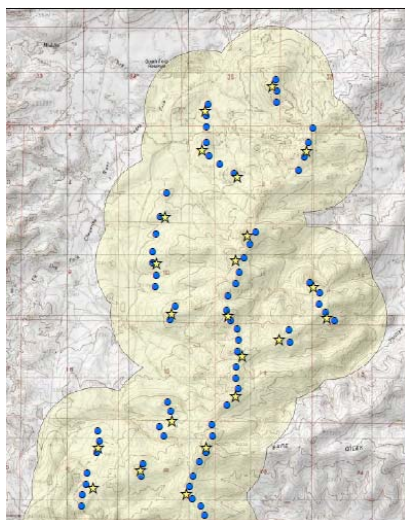
Objectives:

- Product refinements
- Gather statistics on ability to detect, classify, and track eagles
 - Each system independently, and
 - As coordinated system
- Comparison against human observer ability to detect and classify
- Third party peer reviewable verification of IdentiFlight efficacy and reliability (summer 2016)



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Deployment in Windfarm



Northern portion of PacifiCorp Glenrock project, WY
 $N' = 3.2$ [3.2 turbines covered per IdentiFlight.]



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- ✓ Optimum siting of IdentiFlight towers maximizes the visual reach, reducing the number of towers needed and lowering the costs to the customer.
- ✓ Our key ratio describing this is N' which is the ratio of turbines visually covered divided by the number of IdentiFlight camera towers.
- ✓ We are finding N' to typically range between 1.4 and 2.0.
- ✓ As the camera technology improves, this ratio will go up.

Interface To Windfarm



Our focus: Provide to human operator

- ✓ High quality visual information;
- ✓ Curtailment recommendation (via alarm) based on customer prescription.
- ✓ Operators makes the choice to
 - curtail,
 - initiate a deterrent, or
 - monitor the eagle behavior.

Without linking to windfarm infrastructure, we can minimize impacts on ground and windfarm operations

- ✓ Remote power (solar/batteries)
- ✓ Wireless communication
- ✓ Limited ground disturbance
 - grounding rod
 - fencing
 - small pad levelling.



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Operator Risk Tolerance Decisions



	Higher Risk	Lower Risk
Distance criteria	Curtail closer in	Curtail at greater distance
Trajectory criteria	Curtail only for approaching birds	Curtail regardless of trajectory
Uncertainty	Curtail only at low levels of uncertainty	Curtail at higher levels of uncertainty
Layout options	Stretch distances (higher N')	Add more Identiflight towers



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USFWS Bayesian Statistics Model of Eagle Risk



$F = \text{Exposure} \cdot \text{Collision Probability} \cdot \text{Scale factor}$

F = Annual eagle fatality estimate in eagles/year

$\text{Exposure} = \text{GammaDist} \{ p_1 + s_1, p_2 + s_2 \}$

- represents the amount of time an eagle is likely to be in the rotor swept area
- p_1 and p_2 define "prior" distribution data the USFWS derived from previously studied high risk windfarms;
- s_1 and s_2 are eagle minutes observed over the area and time studied during development stage eagle surveys.

$\text{Collision Probability} = \text{BetaDist} \{ p_3 + s_3, p_4 + s_4 \}$

- represents the probability that an eagle in the hazard zone will be killed
- p_3 and p_4 define "prior" distribution data the USFWS derived from previously studied high risk windfarms
- s_3 and s_4 are the fatalities observed in post-construction monitoring and the fatalities that did **not** occur when eagles were in the hazard zone.

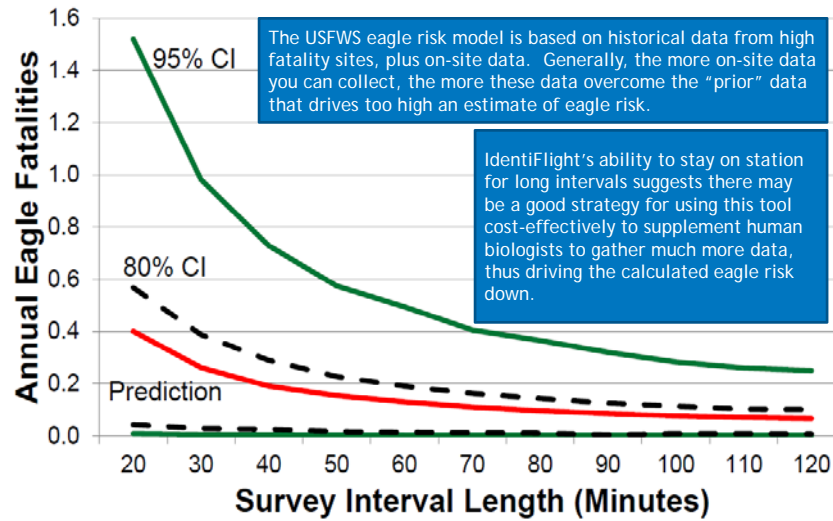
Scale factor scales the fatality estimate up to the size of the windfarm

turbines
daylight hours
rotor swept area



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Longer Survey Interval Decreases Fatality Estimate



Source: Laura Nagy and Chris Farmer, TetraTech 2012

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The Future Of IdentiFlight



Subject to RES/Iberdrola Non-disclosure Agreement

Sustainable Coexistence of Wind and Wildlife





IdentiFlight thanks you!!!

Our eagles thank you too!!!





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