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Evidence of Absence

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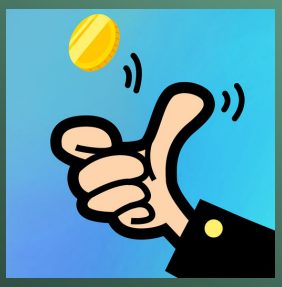
U.S. Department of the Interior
U.S. Geological Survey

1

Analogy: Coin Flip



10 flips…
Best guess # heads?

M = # flips = # Dead
g = Pr(head) = Pr(detect)
X = # heads = # Found

$$M * g = x$$
$$10 * 0.5 = 5$$

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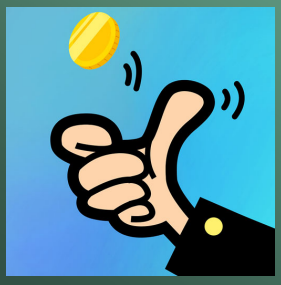
Analogy: Coin Flip



4 heads…
Best guess at # flips?

$$M * g = x \Rightarrow$$
$$M = \frac{x}{g}$$
$$\frac{4}{0.5} = 8$$

95% CI: (3, 13)

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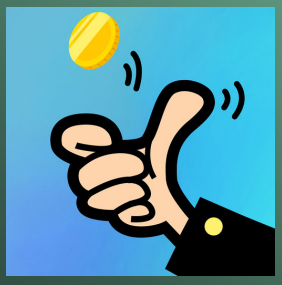
Analogy: Coin Flip



0 heads…
Best guess at # flips?

$$\frac{0}{0.5} = 0$$
$$\frac{0}{0.95} = 0$$
$$\frac{0}{0.05} = 0$$

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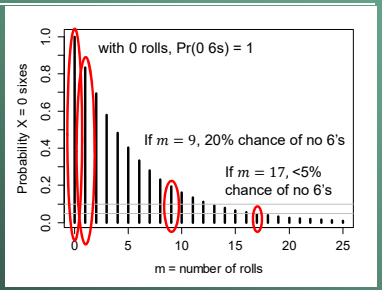
Probability of zero 6's in m dice rolls

$g = P(\text{roll a } 6) = 1/6$

Best guess:
$\hat{M} = 0$

No surprise to roll 10-15 times with no 6's

Can effectively rule out $m \geq 17$ (95% credibility)



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$0 \leq N \leq 17$

Even if we know probability of detection EXACTLY

We will never know fatality EXACTLY

16.7%

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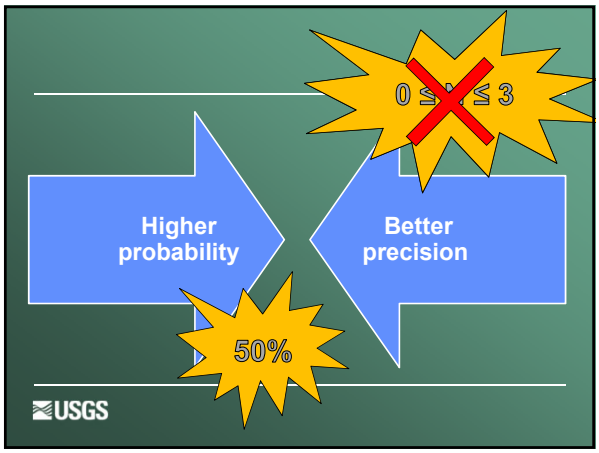


7

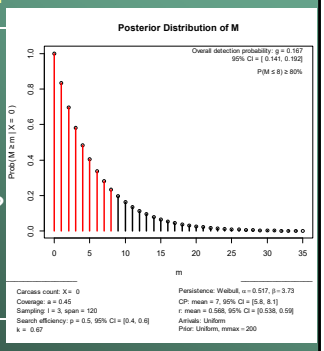
Evidence of compliance

User-provided detection data

+

Observed count

What can we rule out?



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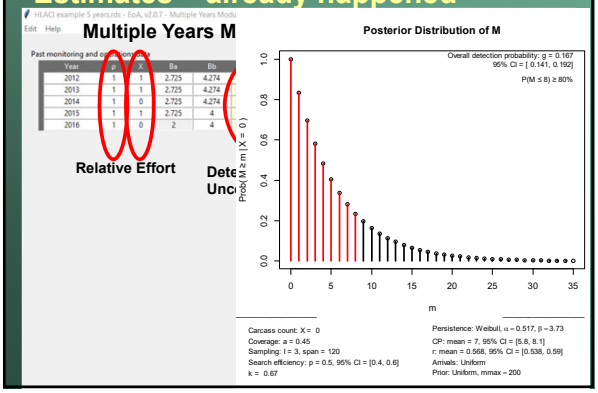
8

Estimates – already happened



9

Application

- How do we set take over the life of a project?
- What do we mean by permitted take?
  - Total take ≤ annual ITP-level * life of the project?
    - e.g., 2/yr * 30 yrs = 60 Total
  - Actual take ≤ annual ITP-level *every* year?
    - e.g., ≤2 every year

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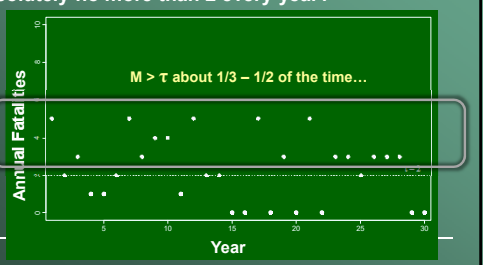
10

Application

- ITP limit (τ) = 2 per year for 30 years
  - Absolutely no more than 2 every year?



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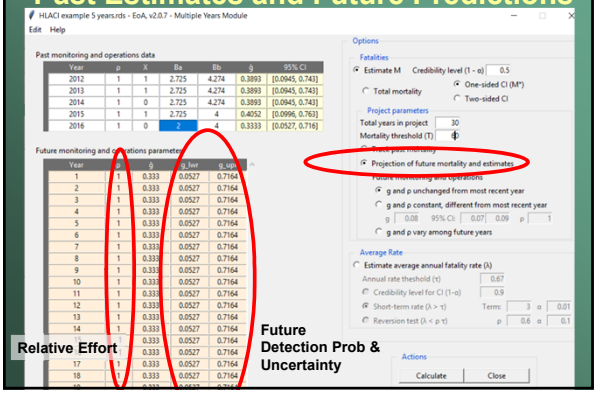
11

Past Estimates and Future Predictions



12

Past Estimates, Future Projections

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Totals through 5 years

M* = 8 for 1 - alpha = 0.5, i.e., P(M <= 8) >= 50%
Estimated overall detection probability: g = 0.381, 95% CI = [0.235, 0.539]
    Ba = 14.403, Bb = 23.369
Estimated baseline fatality rate (for rho = 1): lambda = 1.967, 95% CI = [0.438, 4.89]

Cumulative Mortality Estimates
Year        M*   median   95% CI    mean(lambda) 95% CI
2012         3        3   [1, 20]   6.5940   [   0.3,  30.16]
2013         6        6   [2, 18]   7.7640   [ 1.066,   24.2]
2014         6        6   [2, 15]   7.2050   [ 1.066,   20.8]
2015         8        8   [3, 19]   9.6600   [ 2.117,   24.41]
2016         8        8   [3, 19]   9.8360   [ 2.188,   24.45]

Annual Mortality Estimates
Year        M*   median   95% CI    mean(lambda) 95% CI
2012         3        3   [1, 20]   6.5940   [   0.3,  30.16]
2013         3        3   [1, 20]   6.5940   [   0.3,  30.16]
2014         0        0   [0, 7]    2.1980   [0.001555,     13]
2015         3        3   [1, 19]   6.2670   [0.2877,   28.54]
2016         0        0   [0, 13]   3.9770   [0.002034,  25.23]
```

5 year rate

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13

Estimated Rate (M/yr)

Same # turbines every year
Similar wind regime
Similar bat population

~ constant M/yr
λ

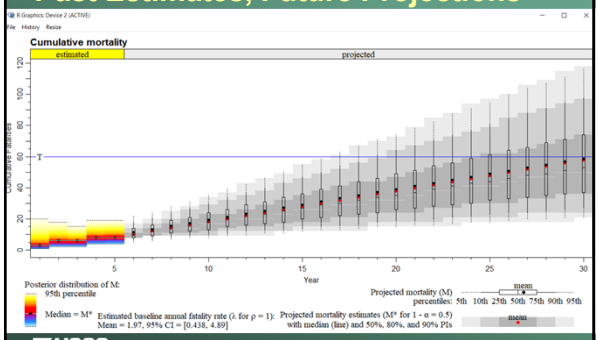
→ **Predicted Rate (M/yr)**

Best guess at future average annual take

Best projection for future annual take – 80th qtl?

14

Past Estimates, Future Projections



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15

The General Framework

- Population may tolerate 60 spread over 30 yrs but not over few years
- Actual take rate (λ) may differ from initial expectations (τ), or may change over time...
- Take advantage of continuous monitoring to reduce necessary detection rate in any given year

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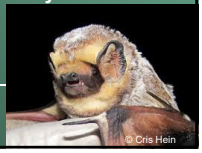
16

General Framework

- ITP set at 2 HLACI per year over 30 years
- Monitoring goal:
  - provide evidence of minimal impact
- Objectives:
  - Long-term – Evidence that total take ≤ 60
    Warning if heading to > 60
  - Short-term – Warning if avg take >> 2/year



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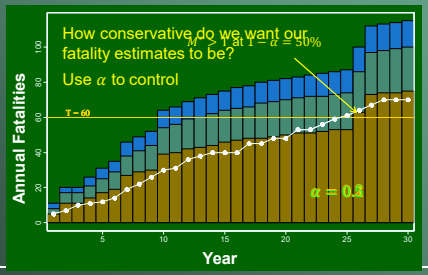
17

Long-term: Warning if T approaches 60

- E.g., ITP defines a total take limit of $T = 60$ over $n = 30$ years



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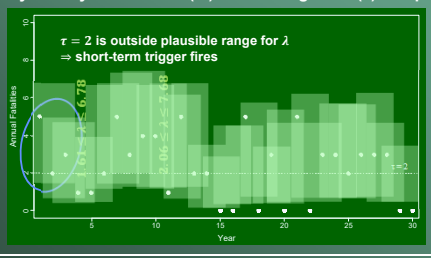
18

Short-term: warning if $\hat{\lambda} > \tau$

Pattern of year-to-year fatalities (M) with average rate (λ) of 2 per year…



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19

Exploring consequences of assumptions – "Triggering" Report

A framework for decision points to trigger adaptive management actions in long-term incidental take permits

Open-File Report 2015-1227 https://pubs.er.usgs.gov/publication/ofr20151227

Prepared in cooperation with U.S. Fish and Wildlife Service

By: Daniel Dalthorp and Manuela M. Huso

https://doi.org/10.3133/ofr20151227

- Predicted take *Correct?··· too high?··· too low?···*
- Level of assurance for long-term?
  50%, 80%, 90% 95%
- Level of assurance for short-term
  80%, 90% 95% 99%

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20

Exploring consequences of assumptions

- Effect on species
  - How often do we exceed long-term limit?
  - By how much?
- Effect on operations
  - How often do we trigger mitigation?
  - For how long?

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21

Summary

Address long-term limit

Cannot say exactly how many taken each year

Can more precisely estimate total over several years

Address short-term feedback

Can warn if take over short pd >> permitted

Project future take

Cannot predict next year's take exactly

Can predict average take *rate* over several years

Can update predictions based on data

Can predict based on anticipated effort

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22

Key References

EoA Software and extensive User Guide

Dalthorp, D., M. Huso, and D. Dail, 2017, Evidence of absence (v2.0) software user guide: U.S. Geological Survey Data Series 1055, https://doi.org/10.3133/ds1055

Extensive testing of EoA model for a wide array of long-term permit scenarios

Dalthorp, D. and M. Huso, 2015, A framework for decision points to trigger adaptive management actions in long-term incidental take permits: U.S. Geological Survey Open-File Report 2015-1227, 88 p., htttp://dx.doi.org/10.3133/ofr20151227.

GenEst Software and extensive User Guide

Dalthorp, D., J. Simonis, R. Wolpert, J. Stuydevant, L. Madsen, F. Korner-Nievergelt, R. Bispo and M. Huso, 2018, A Generalized Estimator of Fatality (v1.0) software user guide: U.S. Geological Survey Data Series *in preparation*

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THANK YOU!

23