US Fish and Wildlife Service – Pacific Southwest Region

Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach

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SUMMARY

Studies examining effects of energy development on mortality of migratory birds has primarily focused on wind energy (California Energy Commission 2006, Huso 2010). Currently, few large scale solar facilities are operational in the United States, and the U.S. Fish and Wildlife Service (USFWS) has little data on the effects of solar facilities on migratory bird mortality. While monitoring programs to study these effects are in place for wind development, there remains a need to provide consistent guidance and study design to quantify mortality of migratory birds at solar power facilities currently and in the future. This document provides methods similar to monitoring for wind developments, but is adapted for solar power facilities. The USFWS Pacific Southwest Region has designed the following monitoring scheme for migratory bird mortality for solar energy development. In this paper, we provide a consistent monitoring design, across different types of solar developments, to estimate the number of bird mortalities and which takes into consideration spatial variation, mortality type, scavenging, and observer detection rates. This method relies heavily on a capture recapture design conducted during 7-day sampling periods at the beginning of each month for a 12 month period. The Service's Pacific Southwest Region is proposing this monitoring regimen for solar energy developments, with the expectation that it will produce adequate data for assessing impacts to migratory birds. As our understanding and techniques for monitoring improve, the Service will adapt the monitoring program in the future.

UNKNOWNS AND METHODS TO RESOLVE

1) Intensity of mortalities – Provide data from initial studies controlling for detection rate, method of mortality, scavenging rate, and locations of mortality. Potential in the future to adapt monitoring protocols for a project based on these initial studies to set monitoring effort.
2) Detection rate – Data from initial studies will inform detection rate as a function of distance from established transect lines. This will allow the initial solar developments to help develop future protocols and set distances from transect line to monitor mortalities.
3) Method of mortalities – Provide data from initial studies. Descriptions of found mortalities and location within development will aide in this assessment. These initial studies will identify where in the solar development mortalities occur and direct future efforts to reduce take due to specific causes.

CONSIDERATIONS

1) Use capture recapture to estimate abundance of dead migratory birds (Lukacs 2011, California Energy Commission 2006).
2) Consider variation in frequency of carcasses that may vary over time and location across and within transects.
3) Consider scavenging rates that may vary over time and location across and within transects.
4) Four general types of solar developments are proposed for development: power tower, solar troughs, Stirling engine, and photovoltaic cells.

SAMPLING DESIGN

1) Strata – We propose 3 strata in this design; 1) within the mirror array and central tower (for power tower developments), 2) ponds, and 3) along transmission lines.
2) Transects – Transects are used as replicates within strata. We propose that transects should cover 10-30% of strata area. Coordinates for transect lines will be established.
3) Extrapolate sampled areas to overall area within each strata.

TRANSECT LAYOUT

Within mirror array and central tower (for power tower developments)

Mirror or photovoltaic cells typically are created in a circular or tetragon shape. Given the difference in these developments, we propose two different approaches to laying out transects. Transect design should result in 10-30% total area coverage within strata. We suggest a minimum of 8 transects within this strata to obtain good replication and enough data to test for effects of distance on mortality events.

CIRCULAR DESGINS WITH A CENTRAL TOWER (power towers)

We propose that transect layout in a power tower array (typically circular) encompasses the 360° area surrounding the central tower (Figure 1). We want to consider detection of carcasses randomly throughout the mirror array. Therefore, we propose to sample 8 transects which originate at the central tower and extend to the edge of the mirror array. These transects shall be at every 45° which should result in 10-30% coverage.

TETRAGON DESIGN

Because this design is simpler than an array with a central potential source of bird mortality, the transect design can also be simpler. All transects should begin and end at an edge of the tetragon (Figure 2).

Ponds

Transects lines should be placed randomly along the immediate edges of ponds (Figure 1) to monitor floating or pulled out carcasses. One transect should occur for each cardinal direction (i.e., north side, south side, east side, and west side) within this strata due to effects of wind or current. If multiple ponds occur, efforts should be made to sample each pond with at least one transect. Minimum of 4 transect in this strata.

Transmission lines

Overall length of the sampled transmission line should be determined and transects should be randomly assigned to result in 10-30% coverage. Transect should run down the middle of the transmissions lines. Minimum of 4 transects in this strata.

SAMPING ALONG TRANSECTS

We encourage the use of a single qualified observer. The observer will walk along pre-determined transects searching for bird carcasses. The observer will walk along the predetermined path and scan away from the transect to detect carcasses. When a carcass is observed, they are asked to walk the shortest distance to the carcass. At each discovery of a carcass, a GPS location (UTM) will be recorded, the species identified and information regarding carcass condition will be collected. Each carcass (not the location) will be uniquely and inconspicuously marked with tape and permanent marker. By recording UTMs, distances from the transect can be calculated for analysis in Program DISTANCE. All carcasses will be left exactly as found. By marking carcasses, future encounters will be used as recaptures. Once data is collected at a carcass, the observer will return to the pre-determined transect and continue with the survey. As all sampling periods will be seven consecutive days, observers will continue to record presence, location (UTM), and condition of all observed carcasses. Table 1 provides a sample data sheet. Carcasses shall be assigned to one of the following 4 classes at each encounter: 1) fresh (eyes are still wet and not totally sunk into sockets), 2) medium (eyes are totally sunk into sockets and breast muscle and viscera still present), 3) non-scavenged carcass (a stiff carcass consisting of a dried complete carcass), 4) remnant (a dried carcass consisting of non-edible parts). Additionally, the presence or absence of evidence of superheating (singed feathers) should be recorded.

DATA TO BE PROVIDED

As this is an experimental approach, the USFWS has a definitive interest in the analysis of the data and the results. Shapefiles showing the solar development including each mirror, tower, building, road, transmission line, transmission tower, and cooling pond are to be provided to USFWS, as are separate shapefiles showing all transects. Completed data sheets, or their copies also should be provided to the Service.

ANALYSIS

Two primary analyses will be conducted. The first will use Program DISTANCE to determine the most effective transect width to search for carcasses. The second will use Program MARK to estimate total number of mortalities controlling for detection rate, scavenging rate, and proximity to the power tower.

Program DISTANCE

The preliminary analyses will benefit from the use of Program DISTANCE to determine the distance from established transects, which detection probabilities remain > 0.95. ARCGIS can use shapefiles containing the transect routes and a separate shapefile identifying the locations of carcasses to develop distances from the transect in which carcasses were detected. This initial analysis will develop protocols in which to sample along transects and whether a set transect width should be implemented in future surveys.

Program MARK

A suggested analysis will use the closed captures design within Program MARK (Lukacs 2011) to estimate the number of dead birds in the sampled area (10-30% of total area). This approach will allow the estimation of number of dead birds (N), apparent survival (Φ) to be the inverse of scavenging rate, and capture probability (p) to be observer detection rate. Therefore, the estimate of the number of carcasses will include variation in scavenger and detection rate. The estimate of number of carcasses will be extrapolated to the full area within each stratum and will be summed to provide an estimate of total number of carcasses for the facility.

Consideration of multiple models will allow determination of source of mortality (e.g., central tower (models including distance from tower is selected)).

ADAPTIVE STRUCTURE

Initially, all transects will be sampled for seven consecutive days at the beginning of each month for a year. We suggest that this year round monitoring program is initiated at the beginning of the most active migratory period for the area. Analyses should be updated seasonally (every 3 months). At the end of the first year, the extrapolated full-year estimate of number of bird mortalities will be considered for future refinement of monitoring protocol.

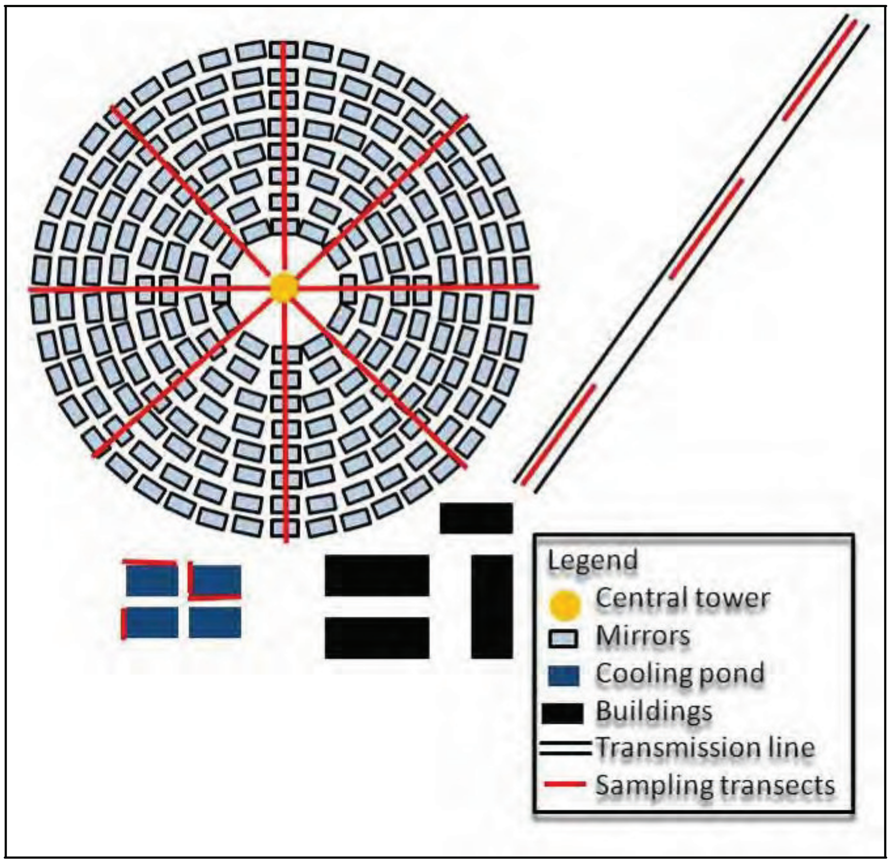

Figure 1. General diagram showing a typical footprint for a circular solar facility with a central power tower. Included is an approximation of the layout for transects to estimate migratory bird mortality.

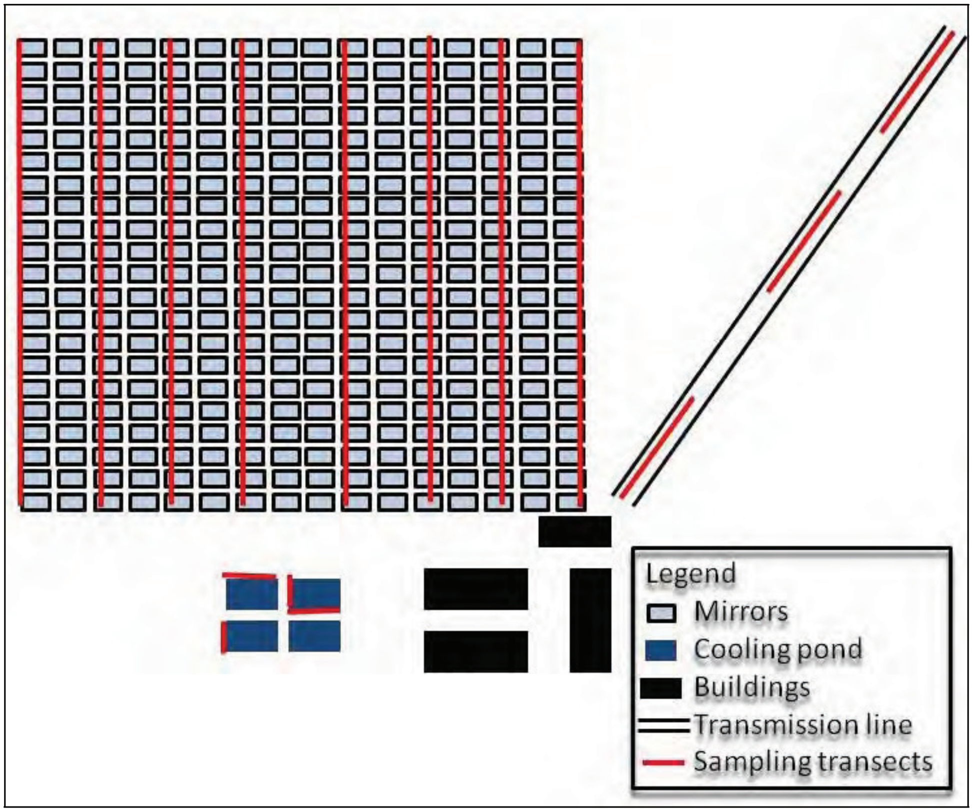

Figure 2. General diagram showing a typical footprint for a tetragon shaped solar facility. Included is an approximation of the layout for transects to estimate migratory bird mortality.

LITERATURE CITED

California Energy Commission. 2006. California guidelines for reducing impacts to birds and bats from wind energy development. Sacramento, CA.

Huso, M. M. P. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics DOI: 10.1002/env.1052

Lukacs, P. 2011. Closed population capture-recapture models *In* Program MARK: A gentle introduction. Online: http://www.phidot.org/software/mark/docs/book/pdf/chap14.pdf

Program DISTANCE. 2011. http://www.ruwpa.st-and.ac.uk/distance/

Program MARK. 2011. http://warnercnr.colostate.edu/~gwhite/mark/mark.htm

SAMPLE DATA SHEET (Excel file is available)

XXX Solar Facility Migratory Bird Monitoring Project

Date:

(use a different sheet for each day)

Observer:

Transect #	Unique Carcass ID	Species	Carcass Condition	UTM	Cause of Death		Transect #	Unique Carcass ID	Species	Carcass Condition	UTM	Cause of Death

Daily Summary

Transect	Total Number of carcasses (include zeros for transects with no carcasses; put X if not sampled)	Transect	Total Number of carcasses (include zeros for transects with no carcasses; put X if not sampled)
Mirror 1		Pond 1	
Mirror 2		Pond 2	
Mirror 3		Pond 3	
Mirror 4		Pond 4	
Mirror 5		Line 1	
Mirror 6		Line 2	
Mirror 7		Line 3	
Mirror 8		Line 4	

Region 8 - Solar ABPP Document Review Checklist

GENERAL CONSIDERATIONS

- ___ The plan considers ALL bird species
- ___ The plan addresses bats
- ___ Plan is written within adaptive management framework

SPECIFIC SECTION CONSIDERATIONS

SITE ASSESSMENT

- ___ Coarse site assessment completed (e.g., RAM, PII)
- ___ Appropriate site specific wildlife surveys completed
  - ___ Protocol eagle/raptor surveys (breeding, wintering, migration)
  - ___ Bird use counts (breeding, wintering, migration)
  - ___ Acoustic bat monitoring
- ___ Additional data sources consulted
- ___ Identifies special status species

IMPACT ANALYSIS

- ___ Species specific threats identified by species
  - ___ Collision with solar technology (e.g., panels, power towers)
  - ___ Burning and blinding from concentrated light
  - ___ Evaporation ponds (i.e., attractive nuisance, hyper-saline toxicity)
  - ___ Transmission line, met tower, guy wire collision
  - ___ Utility electrocution
  - ___ Nest and roost site disturbance
  - ___ Habitat loss
  - ___ Habitat fragmentation
  - ___ Additional human presence disturbance
- ___ Cumulative threats analyzed
  - ___ Eagles
  - ___ Other birds and bats
- ___ Quantitative risk assessment for all species

CONSERVATION MEASURES

- ___ Macro-siting considerations (e.g., placement in least sensitive landscape)
- ___ Micro-siting considerations
  - ___ Avoidance of sensitive habitat fragmentation (e.g., desert washes)
  - ___ Minimize footprint/disturbance area
- ___ Implementation of disturbance buffers
  - ___ Nesting Birds (construction and operation phases)
  - ___ Raptors and Eagles
  - ___ Grouse

- ______ Bats
- ______ Construction Best Management Practices
  - ______ Avoid inclusion of structures for nesting/perching (e.g., lattice towers)
  - ______ Noise reduction/buffers
  - ______ Avoid use of guy wires were possible
  - ______ Bury all electrical lines where possible
  - ______ Tower lighting
  - ______ Minimize access roads
  - ______ Minimize fire potential
  - ______ Vegetation clearance outside of bird breeding season
    - ______ Within breeding season with avoidance surveys
  - ______ Control of non-native plant establishment
  - ______ Control garbage and attractive nuisance sources
- ______ Operational Avoidance and Minimization Measures
  - ______ Minimize features that attract wildlife (e.g., water, nest sites, perches, prey)
  - ______ Implement APLIC standards for utility components
  - ______ Minimize operational noise on adjacent habitat
  - ______ Minimize operational lighting (e.g., motion sensors, shielding, etc)
  - ______ Evaporation pond exclusions

POST-CONSTRUCTION MONITORING

- ______ Assess bird/bat mortality related to solar technology (e.g., collision, burning, blinding)
- ______ Assess bird mortality associated with utilities (e.g., collisions, electrocutions)
- ______ Evaluate bird use of evaporation ponds and effectiveness of exclusion devices
- ______ Assess impacts of fragmentation and displacement
- ______ Eagle monitoring (i.e., nesting, foraging behavior)
- ______ Project site nest management protocols

RISK VALIDATION

- ______ Quantify actual impacts post-operation
- ______ Assess whether conservation measures are adequate to minimize impacts

ADAPTIVE MANAGEMENT APPROACH

- ______ Are additional conservation measures identified
  - ______ Phased-in approach based on triggers
- ______ Mitigation approaches identified
  - ______ Habitat Equivalency Analysis (i.e., pre-construction habitat compensation)
  - ______ Eagle mitigation measures

REPORTING

	Identifies reporting mechanism for project specific data/information

Attachment C