ASSOCIATION *of* FISH & WILDLIFE AGENCIES

State Fish and Wildlife Agency

Solar Siting Survey Final Report

Conducted on behalf of the AFWA Energy & Wildlife Policy Committee

Executive Summary

The Association of Fish & Wildlife Agencies (AFWA) convened a Solar Wildlife Working Group through the Energy and Wildlife Policy Committee in March 2021 to better understand State Fish and Wildlife Agency (SFWA) needs, concerns, and interests related to utility-scale solar siting. The group is composed of SFWA representatives, non-governmental organizations, and industry representatives. The goal of the working group is to collectively assess the potential impacts of utility-scale solar development on wildlife and habitats, to share resources and information about existing state siting, monitoring, and permitting processes, to compile BMPs and/or certification standards, and to increase coordination and networking among members, non-governmental and industry representatives, and states.

The "Solar Siting Survey" was issued to SFWA in all 50 states in December 2021, following the integration of feedback from the Solar Wildlife Working Group on the draft survey questions. The survey results reflect responses received from 41 SFWA who represent 92% of the total megawatts of solar capacity currently installed in the United States. Results were assessed at both a national and regional scale, with regional designations mainly following the U.S. Fish and Wildlife geographic regions. Key findings from the survey include:

- Most respondents (71%) responded that the potential risks to wildlife habitat posed by the development of solar photovoltaics (PV) can sometimes be substantial. Grasslands/prairies ranked most at risk nationally and regionally except in the southeast region that reported agriculture habitat at most risk. Habitat fragmentation (61%) and permanent direct impacts (56%) were the largest concerns nationally.
- Current state requirements for solar PV siting vary, with most states (80%) relying on voluntary approaches to minimize impacts to species and habitat. Sixty-three percent of respondents said that other than requirements for wetland, stream, or listed species, their state does not require developers to coordinate with the state wildlife or natural resource agency on potential wildlife and habitat impacts or require solar PV to avoid, minimize, or offset impacts to species or habitat. Only states in the western regions require early coordination with SFWA. The frequency of early coordination with SFWA and the type of information requested by project proponents varies. However, several respondents

noted that by the time SFWA are contacted, developers have already invested time and resources into the project.

- When solar PV projects do go through an early coordination process with the SFWA, project proponents most frequently request information about the presence of regulated species of concern or their habitat, very general requests for information about species or habitats, and presence of sensitive but unregulated species or their habitat.
- Pre-construction wildlife monitoring and data collection occur more frequently than post-construction, but nonetheless both monitoring types occur infrequently. Most respondents reported that both pre- and post-construction data are helpful for siting and regulatory decisions.
- More than 40% of respondents felt the available science on impacts of solar PV development on wildlife and habitat currently does not address their greatest information needs. Respondents identified a need for more region-specific research on habitats and wildlife impacts and for better accessibility to science findings.
- Respondents overwhelmingly (88% nationally) indicated that solar PV energy guidelines should be developed, similar to the U.S. Fish and Wildlife Service's Land-Based Wind Energy Guidelines. Most respondents (90% nationally) thought these guidelines should be regional in scope.

Based on the survey results, the Solar Wildlife Working Group recommends the following actions:

- **Ensure early coordination:** Identify ways for coordination between project proponents (including consultants, developers, etc.) and SFWA to occur more consistently and earlier in the planning process. Use the resources of AFWA to encourage a nationwide dialogue for developing early coordination protocols between developers and SFWA.
- **Provide relevant state-level information:** Develop tools, maps, and collect data to assist in identifying low-impact siting opportunities and to encourage early coordination with SFWA. Resources should include information most requested by project proponents, such as the presence of state regulated species of concern or their habitat and high-priority conservation areas.
- **Enhance interstate collaboration:** Siting factors and requirements vary across states. Interstate coordination and collaboration can lead to more consistency and enable states to learn from each other. Creation of a resource library for BMPs, guidelines, and geospatial tools could assist in enhancing collaboration and consistency.
- **Collect and share data:** Due to the paucity of data on the impacts of solar development on wildlife, develop standard monitoring protocols to gather more consistent pre-construction and post-construction wildlife monitoring data to assist in future siting

discussions and decisions. Data should be shared with SFWA and other relevant agencies.

- **Conduct additional research:** To address knowledge gaps, states should coordinate with developers to identify and share research needs.
- **Develop solar PV energy guidelines:** Develop nation-wide utility-scale solar PV guidance with region-specific information that focuses on low impact siting.

This survey follows AFWA's Wind Wildlife Working Group's "Wind Siting Survey," issued in 2019. The Final Report for that effort can be found here.

Methods

A 40-question online survey was sent to solar energy points-of-contact at each SFWA in December 2021. Questions included open-ended and multiple-choice answer options; for some, respondents could select more than one answer. The survey results were summarized and reviewed by the Solar Wildlife Working Group and distributed to members of the AFWA Energy & Wildlife Policy Committee in February 2022. The full list of questions can be found in Appendix A.

Results of the survey were analyzed at both a national scale, inclusive of all responding states, and a regional scale. Regions were designated primarily following the U.S. Fish and Wildlife Service regions [1] except in the case of USFWS Regions 1 and 8, which were combined to protect the anonymity of state responses. Regions are hereafter referred to as geographic region as defined in Table 1. Pacific Outlying Area, Nawassa Island, Puerto Rico and Virgin Islands, and Washington D.C. were not issued surveys and are not included in the regional analysis. Further, Region 7 was omitted from results due to incomplete survey responses.

Results

Forty-one (41) SFWAs responded to the survey (Figure 1). The responding states contain 64,096 MW of installed utility-scale solar capacity. There is a total of 69,876 MW of installed utility-scale solar capacity in the US (Figure 2), and as such, the responding states represent 92% of the installed capacity in the US. The number of respondents by region is summarized in Table 1.

[1] United State Fish and Wildlife Regions. "Our Regions"

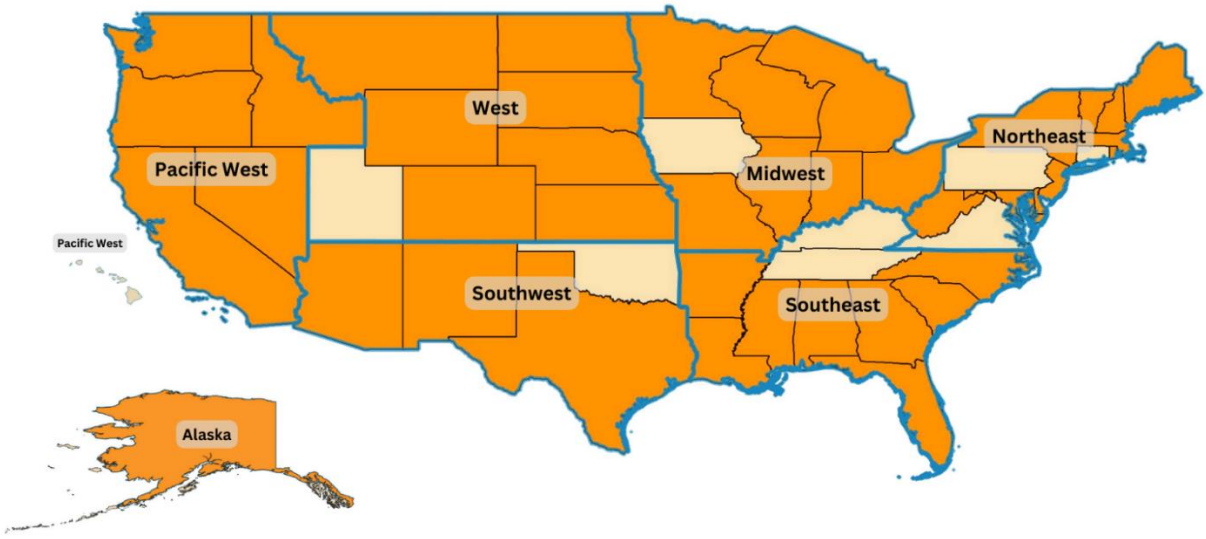

Figure 1. Map of responding states in orange. Blue lines represent the regional boundaries for the region-wide assessment. Regions mainly follow the USFWS geographic regions except that Regions 1 and 8 were combined to protect state anonymity.

Table 1. Regional Response Rate of Survey.

Geographic Region	USFWS Region	Total States in Region	Total States Responding	Share of States Responding
Pacific West	1 and 8	6	5	83%
Southwest	2	4	3	75%
Midwest	3	8	7	88%
Southeast	4	12	8	67%
Northeast	5	13	10	77%
West	6	8	7	88%
Alaska*	7	1	1	100%

*Alaska was omitted entirely from the results presented due to incomplete responses and in order to protect state anonymity

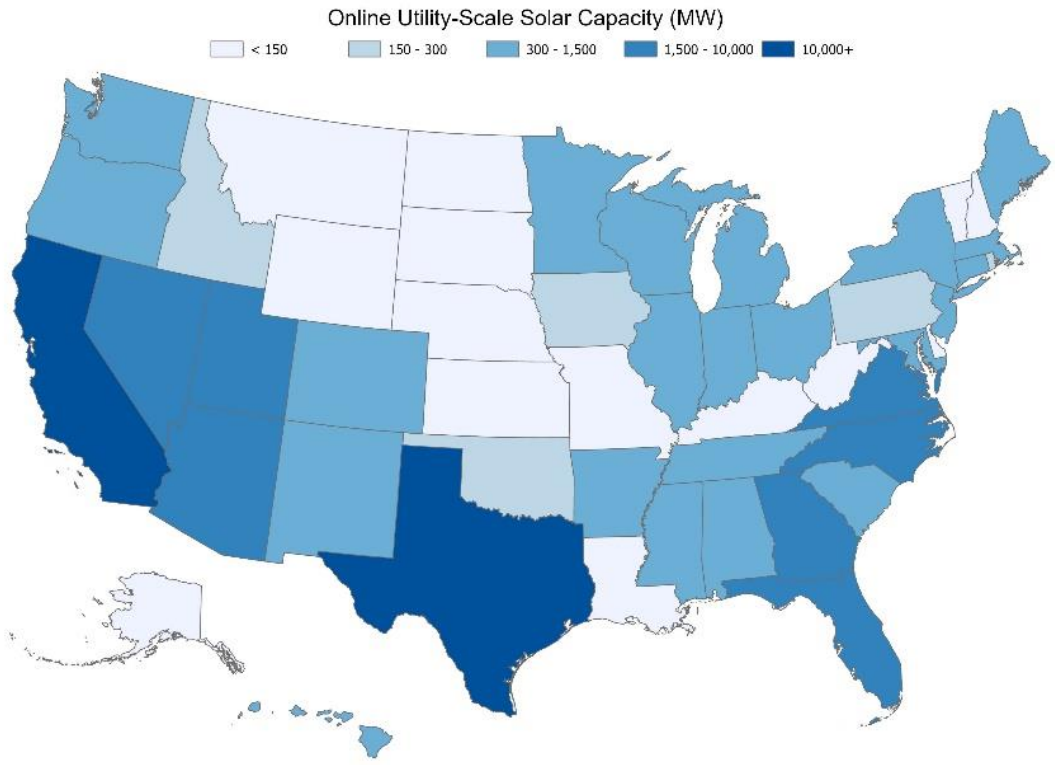

Figure 2. Megawatts of Solar Installation by State[2]

1. Most respondents felt the potential risks to wildlife habitat posed by the development of solar PV can sometimes be substantial, with grasslands/prairies ranked most at risk and habitat fragmentation being the largest concern.

Seventy-one percent of respondents said the potential risks to wildlife habitat posed by the development and operation of PV solar projects sometimes can be substantial, and 22% said the risks tend to be minor. No respondents said that the risks they pose in all cases is substantial or that they do not pose any risks. On average, respondents ranked cumulative (2.4), direct (2.6), and indirect (2.6) impacts as of similar significance to wildlife and habitat from PV solar projects in the foreseeable future (on a scale of 1-5, with 1 being the highest risk). Several respondents noted that the impacts depend on the location of the project. The regional assessment generally followed the national assessment, with each region ranking direct, indirect, and cumulative impacts as similarly significant.

[2] American Clean Power

At a national scale on average, respondents ranked (on a scale of 1-5, with 1 being the highest risk) the following habitat types as most at risk from PV solar projects: grassland/prairie (2), shrub steppe (2.3), and agricultural lands (cropland and grazing lands (2.5). Regionally, grassland/prairie was ranked as most at risk except in the Southeast, which ranked agriculture habitat at most risk. The top five potential impacts from PV solar projects on wildlife ranked as the highest concern, on average were: habitat fragmentation (1.8), species displacement and behavioral changes (1.9), permanent (20+ years) direct impacts to wildlife and habitat (2), cumulative impacts (2.1), and temporary (less than 20 years) impacts to wildlife and habitat (2.3). Potential impacts from PV solar projects on wildlife and habitat varied by region, as shown in Table 2.

Table 2. Highest Concern(s) of potential impacts from PV solar projects on wildlife by geographic region. Equal scores reported for multiple concerns listed.

Geographic Region	**Highest Concern(s)**
Pacific West	Introduction of invasive species, cumulative impacts
Southwest	Barriers to migration, cumulative impacts
Midwest	Cumulative impacts
Southeast	Temporary impacts
Northeast	Permanent impacts, species displacement
West	Permanent impact, habitat fragmentation

2. Current state requirements around solar PV siting vary, with a majority of states relying on voluntary approaches to minimize impacts to species and habitat rather than siting requirements.

Sixty-three percent of respondents said their state does not require developers to coordinate with the state wildlife or natural resource agency on potential wildlife and habitat impacts during the development planning process beyond any requirements that already exist for wetlands, streams, or listed species. Sixty-three percent of states reported their state does NOT require solar PV to avoid, minimize, or offset impacts to species or habitat (separate from any requirements established for wetlands, streams, or listed species). Most (80%) states rely on voluntary approaches or tools to minimize impacts. The full range of existing action types at a national scale are show in in Table 3. However, existing state requirements vary, especially depending on the location (state, county, locality, utility) and the project (e.g., size). Four states in the Pacific West require coordination with SFWA while only 4 other states across Midwest, northeast, and

western region require coordination with SFWA. The full range of state action types by geographic region is show in Table 4.

Table 3. Existing Action Types by Share of States

Does your state…	Yes	No	Other
Require solar PV projects to secure siting approval for construction	29%	37%	34%
Require developers to coordinate with the state wildlife or natural resource agency on potential wildlife and habitat impacts	20%	63%	17%
Make available beneficial practices to inform PV solar projects to minimize impacts to wildlife and habitat [3]	46%	34%	20%
Rely on voluntary approaches or tools to encourage low-impact solar PV siting for wildlife/habitat	80%	13%	8%
Require solar PV to avoid, minimize, or offset impacts to species/habitat separate from any requirements established for wetlands, streams, or listed species	23%	63%	15%
Encourage solar PV to avoid, minimize, or offset impacts to species/habitat	80%	10%	10%

[3] Of those whose state made available beneficial practices or conservation measures, 17 reported they were voluntary, 1 reported they were required, and 5 reported other.

Table 4. Existing Action Types by geographic region. Values represent the share of "yes" responses per region.

Does your state…	Geographic Region					
	Pacific West	**Southwest**	**Midwest**	**Southeast**	**Northeast**	**West**
Require solar PV projects to secure siting approval for construction	80%	0%	0%	25%	60%	14%
Require developers to coordinate with the state wildlife or natural resource agency on potential wildlife and habitat impacts	80%	0%	14%	100%	10%	28%
Make available beneficial practices to inform PV solar projects to minimize impacts to wildlife and habitat	40%	0%	43%	50%	60%	43%
Rely on voluntary approaches or tools to encourage low-impact solar PV siting for wildlife/habitat	60%	100%	71%	75%	80%	100%
Require solar PV to avoid, minimize, or offset impacts to species/habitat	80%	0%	0%	0%	50%	0%
Encourage solar PV to avoid, minimize, or offset impacts to species/habitat	80%	33%	100%	88%	80%	71%

About half of respondents said each of these state actions were "somewhat effective in supporting avoidance, minimize, or compensatory mitigation for impacts to wildlife and habitat from PV solar projects." Pacific West and Southwest regions were more likely than other regions to report that these actions were "not at all effective" (50%), while other regions overwhelmingly reported "somewhat effective." The actions rated as most effective were 1) requiring solar PV projects to secure siting approval for construction and 2) requiring developers to consult with the state wildlife or natural resource agency on potential wildlife and habitat impacts, with 21% of respondents reporting them as "usually" or "extremely" effective. Figure 3 illustrates the effectiveness ratings of each action by share of respondent.

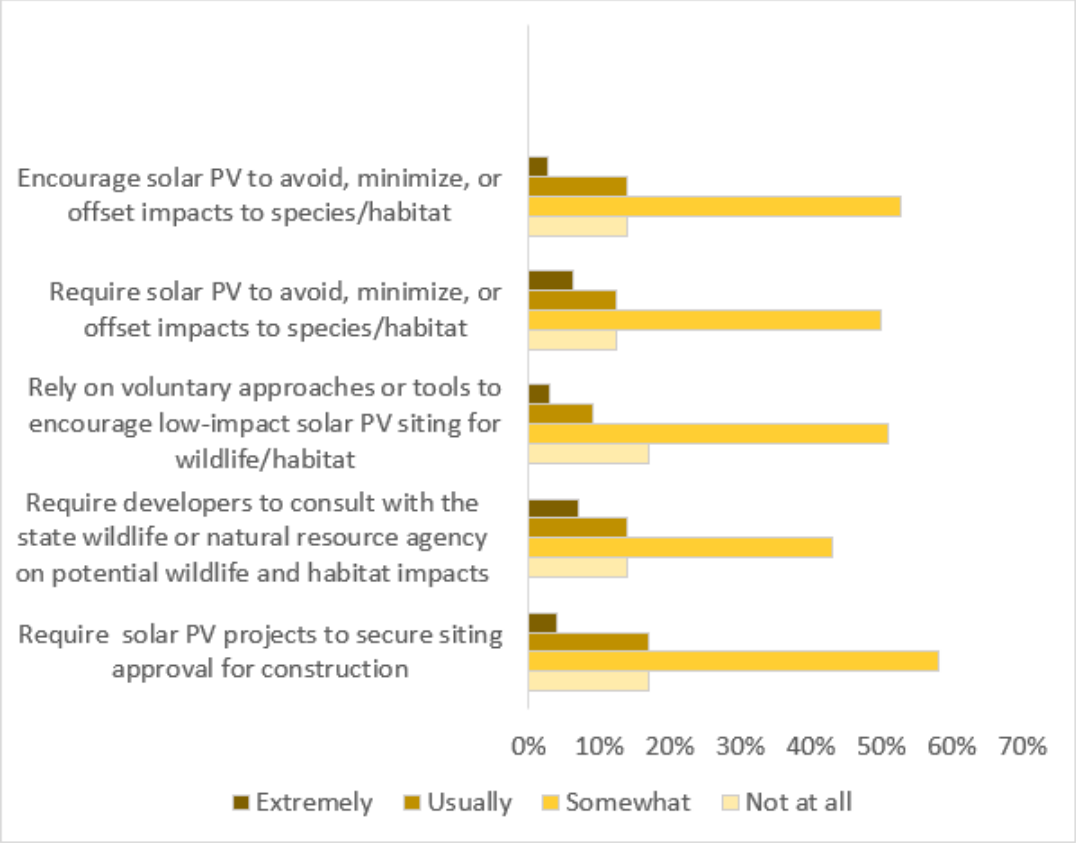

Figure 3. Effectiveness of State Actions

*May not sum to 100% as some "not applicable" (N/A) and "Other" responses are excluded and rounding.

Among the states that responded (n=40), the following are the most common agencies that issue permits and/or approvals: state board of public utilities (n=15), some or all local governments (e.g., county municipality; n=15), and state environmental regulatory agency (n=10). Few agencies require coordination, although the state board of public utilities was also the most common agency in this category (n=4). Table 5 details the breakdown of agency requirements by number of states.

Table 5. Agency Permit/Approval Requirements for PV Projects by Number of States

	Secure approval	Coordination
State board of public utilities	15	4
Some or all local governments (e.g., county, municipality)	15	3
State environmental regulatory agency	10	0
State fish and wildlife agency	8	1

State siting board	6	2
Other	6	2

The following voluntary approaches employed by states to minimize impacts caused by solar developments were the most common: general geospatial siting tools that can be applied to PV solar siting, state PV solar siting guidelines or best management practices, and certification or scorecard for verifying low-impact projects (e.g., pollinator or other wildlife habitat). Table 6 lists all approaches by frequency.

Table 6. Voluntary approaches employed by states to minimize impacts caused by solar development.

Voluntary Approach	Number of Respondents
General geospatial siting tools that can be applied to PV solar siting	14
State PV solar siting guidelines or best management practices	12
Certification or scorecard for verifying low-impact projects (e.g., pollinator or other wildlife habitat)	5
PV solar-specific geospatial siting tools	4
Model local ordinances for low-impact PV solar siting	4
Incentive programs that give preference to low-impact sites (e.g., incentives for siting on brownfields)	2
Other	11

Twenty-nine respondents reported that their state encouraged avoidance (prohibition on development in sensitive wildlife habitat, etc.) and minimization (design stipulations related to fencing, vegetation management, etc.), while 15 said their state required compensatory mitigation/offsets (protecting resources elsewhere or funding conservation actions). Nine states required avoidance of impacts, 12 required minimization, and 10 required compensatory mitigation/offsets.

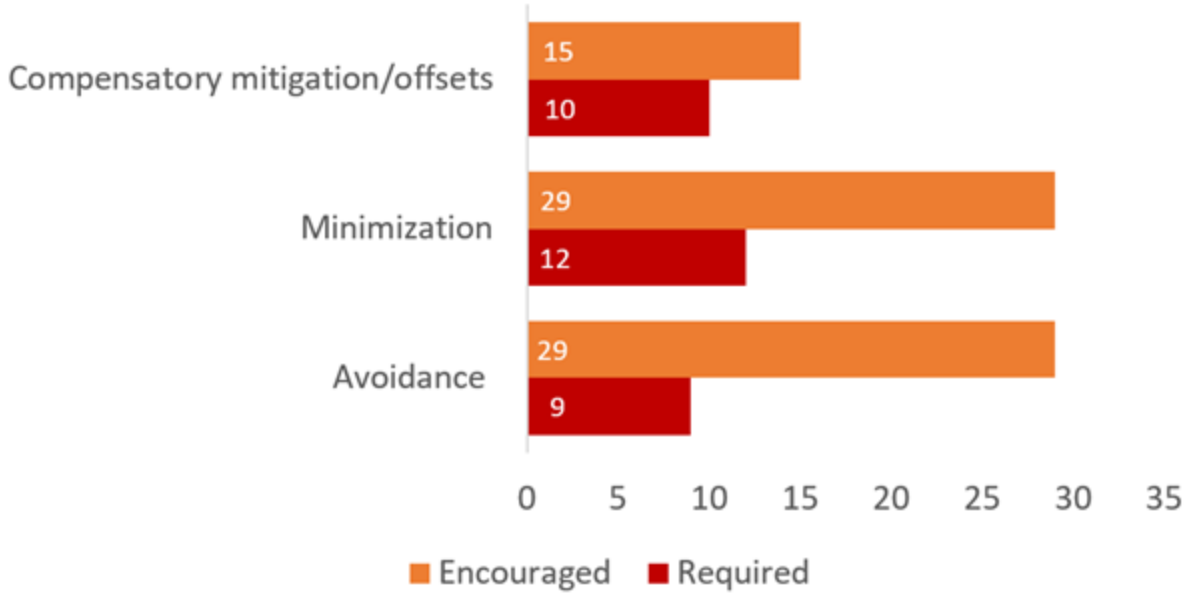

Figure 4. Encouraged and Required Measures by Number of State Respondents

For those states where compensation is encouraged or required, 12 respondents said that compensation is carried out never/almost never, 9 said rarely, 2 said sometimes, 5 said usually, and 3 said always/almost always. Of the respondents who said compensation is sometimes, usually, or always carried out, 4 reported that compensation (in dollars or acres) is determined using a science-based method, 2 said it is a negotiated amount, and 2 said other. However, one respondent noted that in their state: "Compensatory mitigation is extremely rare so far and projects are not avoiding the high priority habitat identified by the agency."

3. The frequency of early coordination processes with state fish and wildlife agencies and type of information requested varies.

Eight percent of respondents reported that early coordination was conducted with state fish and wildlife agencies always/almost always, 15% reported they were conducted usually, 23% reported they were conducted sometimes, 36% reported they were conducted rarely, and 18% reported they were never/almost never conducted (Figure 5).

In the Pacific West region, 40% of states reported early coordination was conducted usually and 40% reported rarely, while 66% of the Southwest region reported that early coordination was conducted rarely. The Midwest region reported that 57% of early coordination occurred sometimes or usually. The Southeast region varied widely in the frequency of early coordination with 25% reporting never, 38% reporting rarely, 25% reporting sometimes and 13% reporting usually. Twenty percent of the Northeast region reported coordination was never conducted and 20% reported early coordination always occurred. 29% of the West region reported coordination never occurred, 38% rarely, and 14% both sometimes and usually.

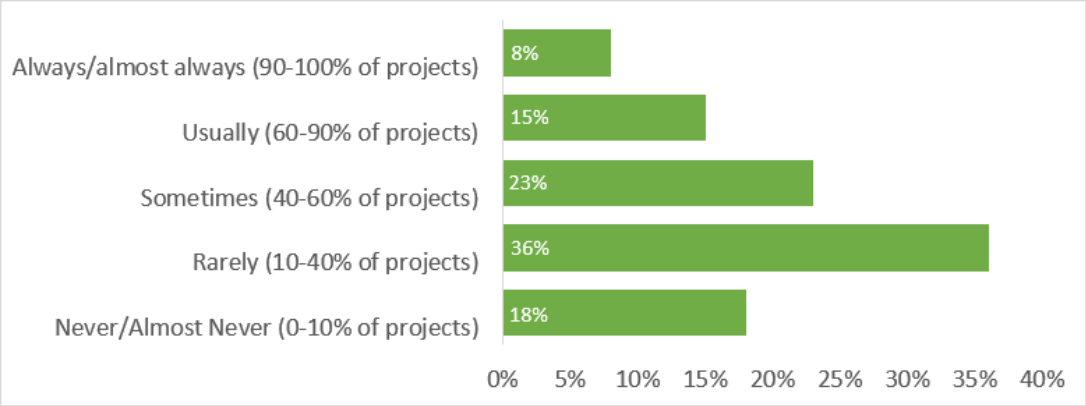

Figure 5. Frequency of Early Coordination Process[4]

When PV solar projects do go through an early coordination process with a SFWA the following information is the most frequently requested: presence of regulated species of concern or their habitat, very general requests for information about species or habitats, and presence of sensitive but unregulated species or their habitat. Other information requested is listed by frequency in Table 7.

Table 7. Information Requests in Early Coordination Process

Information Requested	Share of Respondents
Presence of regulated species of concern or their habitat	83%
Very general requests for information about species or habitats of interest to the agency	44%
Presence of sensitive but unregulated species or their habitat	37%
High-priority conservation areas	34%
Agency recommendations on effective approaches to minimize impacts	34%
Known critical areas of wildlife congregation	27%
Agency recommendations on effective approaches to compensate for impacts to species and habitat	12%
Areas of intact habitat sensitive to the effects of fragmentation	10%
Data regarding species migration routes or patterns	7%
Presence of habitat sensitive to erosion and sedimentation	2%
Any other required permits or regulations they need to be aware of	2%
Requirements for gaining approval	2%

[4] May not sum to 100% due to rounding and "Don't know" responses are excluded.

Early coordination varies by state. However, many respondents agreed that, if coordination occurs, it often happens late in the project development process. Comments by respondents on this subject included:

- "Much of the project has already been designed by that point."
- "Many of them go through us, but their siting decisions are typically already made, and they are just checking boxes."
- "Most projects come to the agency once land acquisition is complete and often when the layout [is] determined."
- "All projects consult early before permitting but have already spent a lot of time and money."
- "By the time it comes to a permitting agency, the site has already been select[ed] and most avoidance opportunities (landscape scale) have been lost."

One respondent noted that, "For those that consult, I have been pleasantly surprised at their willingness to make changes." However, another noted, "It's difficult to know whether developers are following through with these recommended actions." Respondents suggested that "developers need to consult with resource agencies BEFORE leases and additional time and funding are spent" and "solar developers need to reach out to state resource agencies FIRST."

4. Pre-construction wildlife monitoring and data collection occurs more frequently than post-construction. Most respondents report that both pre- and post-construction data is helpful for siting and regulatory decisions.

Pre-construction wildlife monitoring generally occurs more frequently than post-construction wildlife monitoring, but still does not occur frequently. Forty percent of respondents reported that pre-construction monitoring is never/almost never undertaken, while 45% of respondents reported that post-construction monitoring is never/almost never undertaken. Figure 6 shows the frequency of pre-construction and post-construction wildlife monitoring undertaken.

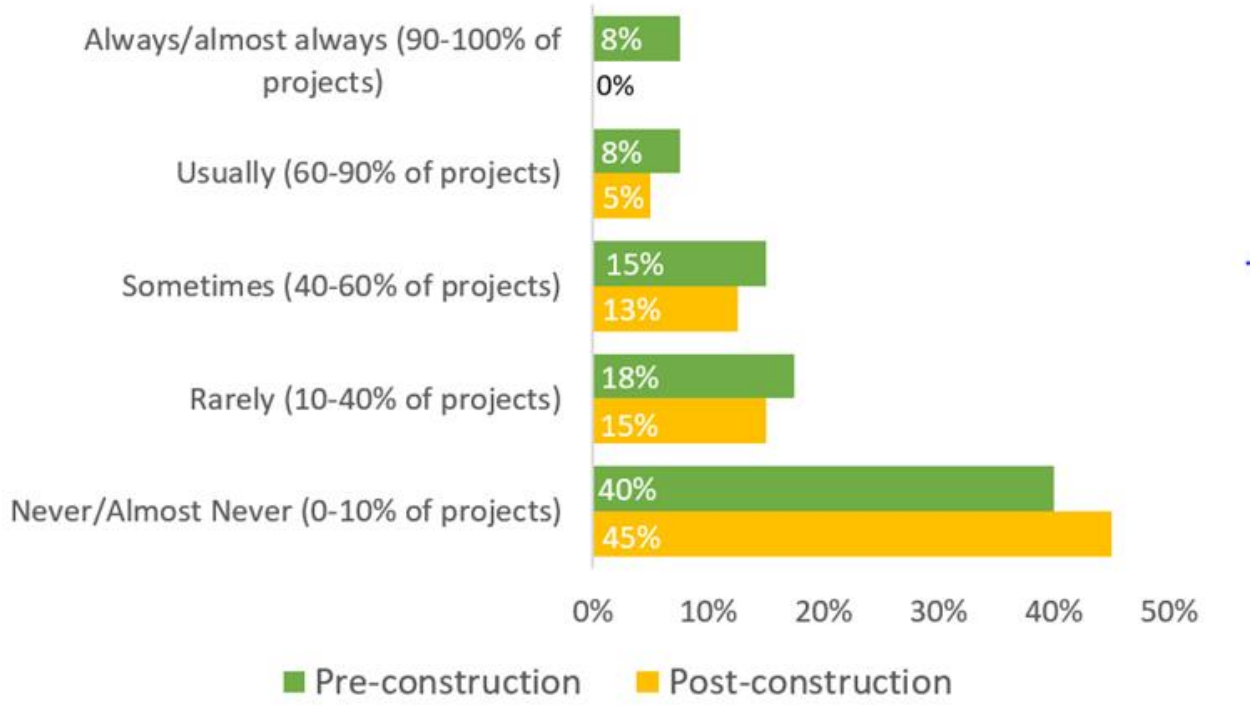

Figure 6. Frequency of pre-construction and post-construction wildlife monitoring undertaken on solar facilities.

Monitoring frequency varied by region. The Pacific West was the only region to report that pre-construction wildlife monitoring is "always" undertaken (50% of states). No region reported post-construction monitoring is undertaken "always". In The Pacific West, 40% reported that post-construction monitoring "usually" occurred. The majority of states in the Southwest, Southeast, and West regions "never" undertake post-construction monitoring.

Similarly, if data are collected, pre-construction data are shared more frequently than post-construction data. Respondents (13%) reported that all pre-construction wildlife monitoring data are shared with their agency, 33% reported some but not all are shared, and 13% reported that no data are shared.[5] A combined 83% of respondents said that pre-construction monitoring data are somewhat or very helpful for informing siting/regulatory decisions. The regional findings aligned with the national findings. Few respondents (3%) reported that all post-construction wildlife monitoring data are shared with their agency, with 21% reporting that some but not all are shared, and 15% reporting that no data are shared. Sixty-five percent of respondents said that post-construction monitoring data are helpful for informing siting/regulatory decisions. A majority of states (>66%) across all Regions except the West think post-construction monitoring data would be helpful to inform siting and regulatory decisions. Respondents also expressed in their open-ended responses that post-construction monitoring is "particularly important both to

[5] Responses may not sum to 100% due to N/A and "I don't know" responses being excluded.

confirm that assertions the developer made pan out, as well as to monitor the effectiveness of conservation measures of mitigation requirements" and "is critical for understanding when adaptive management should be implemented, or when conditions of approval/other limitations have been compromised or otherwise not complied with."

5. SFWA identified the need for more region-specific research on habitats and wildlife impacts and for better accessibility of science.

SFWA would benefit from research that is focused on information gaps and by improved accessibility of existing research. One respondent noted, "Indirect and cumulative impacts to wildlife are unknown but have potential to be significant. More research is desperately needed." Another respondent stated there is a "lack of ease of access to research findings and lack of research in general." One said, "There is much to learn." And another said, "I believe there are still many "unknowns" about the impacts associated with solar arrays."

A combined 70% of respondents said they either have or somewhat have access to the best available science on the impacts of PV solar projects on wildlife and habitat. However, 43% of respondents felt that the available science on impacts of solar PV development on wildlife and habitat currently do not address their greatest information needs, with 38% saying it somewhat or not completely addressed information needs. One respondent said, "I don't have much confidence that I have access to the most complete, regionally applicable, or up-to-date information." At a regional scale, only the Pacific West region reported that available science is addressing greatest information needs, whereas the Southwest, Midwest, Northeast, and the West regions reported that the available science is only somewhat addressing their needs.

On average (on a scale from 1-5 with 1 being the highest), respondents ranked the following as their greatest solar-wildlife science needs (listed in order of average importance): (1) Birds: Strategies to avoid, minimize, and compensate for impacts; (2) Indirect impacts of PV solar on wildlife habitat use, displacement, or behavior; (3) State-of-the-science summaries of solar-wildlife impacts; (4) Best management practices to reduce development impacts; and (5) cumulative impacts of PV solar projects on species and habitat. Specifically, respondents identified research needs for regional-specific wildlife and habitat impacts, with the Great Plains, Midwest, and Northeast mentioned explicitly. Additional topics for future research included impacts to avian, big game, grassland birds, pollinators, herptiles, aquatic organisms impacted by floating solar, and the impact of PV solar maintenance on wildlife, grassland, and shrub steppe soils. Several respondents also mentioned research needs about fencing impacts and design. Regions tended to agree on science needs except for the following: The Southwest ranked science on wildlife fatality rates from development and operation as a higher need than other regions. The Pacific West region ranked best practices for post construction monitoring as higher in need than other regions who all ranked this issue as relatively low need.

Respondents most frequently received information on solar-wildlife science from the Association of Fish and Wildlife Agencies (65%), peer reviewed journals (55%), and the U.S. Fish and Wildlife Service (53%). Respondents would prefer updates on solar-wildlife science by email

(83%), webinar presentations (65%), workshop-style (55%), and in newsletters (35%). Four respondents also specifically noted that Renewable Energy Wildlife Institute (REWI; formerly AWWI) as a source. However, respondents mentioned they would benefit from easier access to research; one respondent said that some research is not publicly available, which provides a barrier, while another said, "access can overall be difficult to obtain."

6. Respondents overwhelming think solar PV energy guidelines similar to wind should be developed, especially at a regional level.

The majority of respondents nationally (88%) and regionally said they thought that national or regional PV solar energy guidelines, similar to the U.S. Fish and Wildlife Service's Land-Based Wind Energy Guidelines[6], should be developed. While no respondents said no, but 12.5% said they don't know. As one respondent shared, "Many solar developers already use the FWS wind energy guidelines. There is demand."

The majority of respondents also thought these guidelines should be regional (90%) in scope as opposed to national (15%) or other (13%)[7]. A respondent pointed out that, "solar more than wind has regional differences in impacts that should be addressed." Respondents suggested cohesive nation-wide guidance that contain region-specific guidance, potentially even sub-regional guidance like at the state or eco-region level. Respondents identified that specific guidance would be especially helpful on new types of siting scenarios like floating solar, as well as on wildlife fencing.

Discussion

This solar siting survey of state fish and wildlife agencies is the first of its kind to our knowledge. Responses varied by state and even between regions as states have very different regulatory and policy landscapes. Similarly, some states noted they had a smaller sample size of projects due to solar energy projects being either fewer or newer. Nonetheless, the results from this survey will help the AFWA Energy & Wildlife Policy Committee and others identify needed actions to address identified issues. Likewise, the information in the survey will be of interest to the solar industry to help in their work to partner with SFWA to avoid, minimize, and offset (provide compensatory mitigation) for impacts to wildlife.

Upon completion of the survey analysis, The Solar Wildlife Working Group identified the following priorities and next steps for responsible solar siting.

- **Ensure early coordination:** Identify ways for coordination between project proponents (including consultants, developers, etc.) and SFWA to occur more consistently and earlier

[6] The U.S. Fish and Wildlife Service's Land Based Wind Energy Guidelines were developed in 2019
[7] Note: sometimes responses do not sum to 100% due to rounding or the exclusion of respondents who answered "N/A" or "Other."

in the planning process. Use the resources of AFWA to encourage a nationwide dialogue for developing early coordination protocols between developers and SFWA.

- **Provide relevant state-level information:** Develop tools, maps, and collect data to assist in identifying low-impact siting opportunities and to encourage early coordination with SFWA. Resources should include information most requested by project proponents, such as the presence of state regulated species of concern or their habitat and high-priority conservation areas.
- **Enhance interstate collaboration:** Siting factors and requirements vary across states. Interstate coordination and collaboration can lead to more consistency and enable states to learn from each other. Creation of a resource library for BMPs, guidelines, and geospatial tools could assist in enhancing collaboration and consistency.
- **Collect and share data:** Due to the paucity of data on the impacts of solar development on wildlife, develop standard monitoring protocols to gather more consistent pre-construction and post-construction wildlife monitoring data to assist in future siting discussions and decisions. Data should be shared with SFWA and other relevant agencies.
- **Conduct additional research:** To address knowledge gaps, states should coordinate with developers to identify and share research needs.
- **Develop solar PV energy guidelines:** Develop nation-wide utility-scale solar PV guidance with region-specific information that focuses on low impact siting.

Appendix A. Survey Questions

1. Are you the main point of contact for your state's fish and wildlife agency on solar siting? (Choose one.) Please note we are asking for only one survey submission per state. If you have multiple solar points of contact, please coordinate as needed. Thank you.

2. How would you characterize the potential risks to wildlife and habitat posed by the development and operation of PV solar projects in your state in the foreseeable future? (Choose one.)

3. Please identify how significant the different types of impacts are to wildlife and habitat from PV solar projects in your state in the foreseeable future with 1 being the highest risk. See definitions above.

   a. Direct Impacts

   b. Indirect Impacts

   c. Cumulative Impacts

   d. Other (specify below)

4. Please identify the habitat types most at risk from PV solar projects on a scale of 1 to 5 with 1 being the highest concern. Select all that apply. Please provide additional specificity in the box below.

   a. Grassland/prairie

   b. Agricultural lands (cropland and grazing lands)

   c. Forest

   d. Wetlands

   e. Desert

   f. Shrub steppe

   g. Other (specify below)

5. Please identify your level of concern about the following types of potential impacts from PV solar projects on wildlife and habitat on a scale of 1 to 5 with 1 being the highest concern.

   a. Erosion

   b. Stream sedimentation

   c. Permanent (20+ years) direct impacts to wildlife and habitat from the installation of PV solar projects and related infrastructure

d. Temporary (less than 20 years) impacts to wildlife and habitat from the installation of PV solar projects and related infrastructure

e. Direct impact to wildlife species from the operation of PV solar projects and related infrastructure

f. Habitat fragmentation

g. Species displacement and behavioral changes

h. Barriers to local or long-distance migration (e.g., ungulates)

i. Introduction of invasive species

j. Cumulative impacts

k. Other (specify below)

6. Does your state require PV solar projects to secure siting approval specifically for construction, such as a permit, other than permits under existing requirements for wetland, stream, or listed species?

7. If you answered yes to the last question on Page 1 (i.e., PV solar projects are required to secure approval), what agency issues permits and/or approvals? Select all that apply.

a. Not applicable (i.e., PV solar projects are not required to secure approval)

b. State fish and wildlife agency

c. State environmental regulatory agency

d. State siting board

e. State board of public utilities

f. Some or all local governments (e.g., county, municipality)

g. Other (please specify)

8. If you answered yes to the last question on Page 1 (i.e., PV solar projects are required to secure approval), how effective do you think the process is at supporting avoidance, minimize, or compensatory mitigation for impacts to wildlife and habitat from PV solar projects? Please provide additional specificity in the box below.

9. Does your state require developers to consult with the state wildlife or natural resource agency on potential wildlife and habitat impacts during the development planning process in addition to any requirements that already exist for wetlands, streams, or listed species? Note: Additional questions on voluntary approaches below.

10. If you answered yes to the last question on Page 2 (i.e., PV solar developers are required to consult), what agency requires the consultation?

11. If you answered yes to the last question on Page 2 (i.e., PV solar developers are required to consult), how effective do you think the process is at supporting avoidance, minimize, or compensatory mitigation for impacts to wildlife and habitat from PV solar projects?

12. Has your state made available beneficial practices or conservation measures to inform the siting, site design, or operation of PV solar projects to avoid, minimize, or offset impacts to wildlife and habitat? Please provide additional specificity in the box below and a citation with links.

13. If you answered yes to the last question on Page 3 (i.e., your state has made available beneficial practices or conservation measures to mitigate impacts from PV solar on wildlife and habitat), are these standards required or voluntary?

14. Does your state rely on voluntary approaches or tools (e.g., encouragement to consult early, state-specific solar siting guidelines, best management practices, geospatial siting tools, outreach program) to encourage PV solar siting that is low impact for wildlife and habitat?

15. If you answered yes to the last question on Page 4 (i.e., your state relies on voluntary approaches), what approaches has your state tried? (Check all that apply and please provide links to guidelines, siting tools, incentive programs, etc., under additional information.)

a. Not applicable (i.e., state does not rely on voluntary approaches)

b. Outreach to developers to encourage early consultation with the agency

c. State PV solar siting guidelines or best management practices

d. PV solar-specific geospatial siting tools

e. Certification or scorecard for verifying low-impact projects (e.g., pollinator or other wildlife habitat)

f. General geospatial siting tools that can be applied to PV solar siting

g. Incentive programs that give preference to low-impact sites (e.g., incentives for siting on brownfields)

h. Model local ordinances for low-impact PV solar siting

i. Other (specify below)

16. If you answered yes to the last question on Page 4 (i.e., your state relies on voluntary approaches), how effective do you think the approach has been in facilitating low wildlife-impact PV solar projects? Please provide additional information on why these approaches have or have not been effective in the box below.

17. How frequently do PV solar projects go through an early (i.e., pre-design) consultation process with the state fish and wildlife agency to assess potential impacts to wildlife and habitat?

18. When PV solar projects do go through an early consultation process with the state fish and wildlife agency, what types of information do they most frequently request? (Check all that apply.)

a. Not applicable (I answered "never" or "rarely" to question 18)

b. Presence of regulated species of concern or their habitat

c. Presence of sensitive but unregulated species or their habitat

d. High-priority conservation areas

e. Known critical areas of wildlife congregation

f. Areas of intact habitat sensitive to the effects of fragmentation

g. Presence of habitat sensitive to erosion and sedimentation

h. Data regarding species migration routes or patterns

i. Very general requests for information about species or habitats of interest to the agency

j. Agency recommendations on effective approaches to minimize impacts

k. Agency recommendations on effective approaches to compensate for impacts to species and habitat

l. Other (specify below)

19. Do you think that national or regional PV solar energy guidelines similar to the U.S. Fish and Wildlife Service's Wind Energy Guidelines should be developed? (Choose one.)

20. If you answered yes to the last question on Page 5 (i.e., you think national or regional PV solar energy guidelines should be developed), at what scale do you think they should be developed (choose all that apply):

a. Not applicable (i.e., I do not think national or regional PV solar energy guidelines should be developed)

b. National

c. Regional

d. Other (specify below)

21. Should a Migratory Bird Treaty Act general permit for incidental take be developed for PV solar energy based on available beneficial practices or conservation measures?

22. Do you think that you have access to the best available science on the impacts of PV solar projects on wildlife and habitat? Additional information can be provided in the box below. (Choose one.)

23. Is the available science on impacts of solar PV development on wildlife and habitat addressing your greatest information needs? Additional information can be provided in the box below. (Choose one.)

24. From what sources do you receive information on solar-wildlife science? (Check all that apply.)

a. Association of Fish and Wildlife Agencies (AFWA)

b. Solar association(s)

c. National Renewable Energy Lab (NREL)

d. Department of Energy

e. The Wildlife Society (TWS)

f. U.S. Fish and Wildlife Service (USFWS)

g. U.S. Geological Survey (USGS)

h. Peer reviewed journals

i. Other (specify below)

25. Please rank your greatest solar-wildlife science needs, with 1 being the highest.

a. State-of-the-science summaries of solar-wildlife impacts

b. Birds: Strategies to avoid, minimize, and compensate for impacts

c. Mammals: Strategies to avoid, minimize, and compensate for impacts

d. Reptiles/Amphibians: Strategies to avoid, minimize, and compensate for impacts

e. Indirect impacts of PV solar on wildlife habitat use, displacement, or behavior

f. Impacts of PV solar on habitat connectivity and wildlife migration

g. Best management practices to reduce development impacts

h. Solar siting analysis tools

i. Science on wildlife fatality rates from development and operation

j. Best practices for pre-construction monitoring

k. Best practices for post-construction monitoring

l. Examples of binding conditions in environmental reviews

m. Effective approaches to mitigating or compensating for impacts to habitat

n. Cumulative impacts of PV solar projects on species and habitat

o. Examples of conservation success stories associated with PV solar projects

p. Other (specify below)

26. If you want regular updates on solar-wildlife science, how would you prefer to receive this information? (Check all that apply.)

a. Not applicable (i.e., I am not interested in receiving more regular updates)

b. Via email

c. Via newsletters

d. Via webinar presentations

e. Workshop-style in association with the North American, AFWA Annual Meeting, or regional wildlife agency meetings

f. Other (specify below)

27. To your knowledge, how frequently is pre-construction wildlife monitoring undertaken for PV solar projects in your state? Please select one.

28. If collected, how much pre-construction wildlife monitoring data is shared with your agency? Please select one.

29. If collected, do you think that pre-construction monitoring data is or would be helpful for informing siting/regulatory decisions? Please select one.

30. To your knowledge, how frequently is post-construction wildlife monitoring undertaken for PV solar projects in your state? Please select one.

31. If collected, how much post-construction wildlife monitoring data is shared with your agency? Please select one.

32. If collected, do you think that post-construction monitoring data is or would be helpful for informing siting/regulatory decisions? Please select one.

33. In your state, are PV solar projects required to avoid, minimize, or offset impacts to species and/or habitat separate from any requirements established for wetlands, streams, or listed species? (Choose one.)

34. If you answered yes to the last question on Page 6 (PV solar projects are required to avoid, minimize, or offset impacts), what measures are required? Select all that apply.

a. Not applicable (i.e., PV solar projects are not required to avoid, minimize or offset impacts)

b. Avoidance (prohibition on development in sensitive wildlife habitat, etc.)

c. Minimization (design stipulations related to fencing, vegetation management, etc.)

d. Compensatory mitigation/offsets (protecting resources elsewhere or funding conservation actions)

35. If you answered yes to the last question on Page 6 (PV solar projects are required to avoid, minimize, or offset impacts), how effective do you think these requirements have been at encouraging low wildlife-impact siting? (Choose one.)

36. In your state, are PV solar projects encouraged to avoid, minimize, or offset impacts to species and/or habitat separate from any requirements established for wetlands, streams, or listed species?

37. If you answered yes to the last question on Page 7 (i.e., PV solar projects are encouraged to avoid, minimize, or offset impacts), what measures are encouraged? Select all that apply.

a. Not applicable (i.e., PV solar projects are not encouraged to avoid, minimize, or offset impacts)

b. Avoidance of impacts to species of greatest conservation need and their habitat

c. Minimization of impacts

d. Compensatory mitigation

e. Other (specify below)

38. If you answered yes to the last question on Page 7 (i.e., PV solar projects are encouraged to avoid, minimize, or offset impacts), how effective do you think these measures have been at addressing impacts to wildlife and habitat?

39. If you indicated above that PV solar developers are encouraged or required to compensate for impacts to species/and or habitat, how frequently do you think compensation is carried out?

40. If you answered yes to the last question on Page 8 (i.e., compensatory mitigation is carried out sometimes, usually, or always), how is the amount (dollars or acres) of compensation determined?

[1] Solar Energy Industries Association. "Solar State by State."

[2] Solar Energy Industries Association (2022). "Solar Industry Research Data." Accessed August 18, 2022. https://www.seia.org/solar-industry-research-data

3 US Fish and Wildlife Service Regions. https://www.fws.gov/about/regions

[3] Of those whose state made available beneficial practices or conservation measures, 17 reported they were voluntary, 1 reported they were required, and 5 reported other.

[4] May not sum to 100% due to rounding, exclusion of "Don't know" responses, and respondents can select more than one answer.

[5] Responses may not sum to 100% due to N/A and "I Don't Know" responses being excluded.

[6] The U.S. Fish and Wildlife Service's Wind Energy Guidelines were developed in 2019.

[7] Note: sometimes responses do not sum to 100% due to rounding or the exclusion of respondents who answered "N/A" or "Other."