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Criteria for Selecting Animal Species for the USA National Phenology Network

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Introduction

The following criteria guide the selection of animal species that the USA National Phenology Network (USA-NPN) recommends for monitoring. The overarching goals for species selection are (1) to select species appropriate for citizen scientists or professionals to monitor and (2) to optimize the amount of data collected, the quality of the data, and the value of the data to research, management and education. For some species, particularly those that are dangerous to people and those that are threatened or endangered, we will recommend that only professional biologists monitor them.

Summary of criteria

I. Characteristic required of all monitored species
    a. Current knowledge about the species' natural history
II. Characteristics required of species to be monitored by beginning citizen scientists
    a. Ease of identification
    b. Ease of observation and data collection
    c. Relative abundance
III. Optional but desirable characteristics of monitored species
    a. Taxonomic stability and clarity
    b. Existence of legacy data sets
    c. Existence of ongoing long-term monitoring stations
    d. No permits required for observation
    e. Broad distribution
    f. Occurrence in Alaska, Hawaii, or U.S. island territories
    g. Ecological importance
    h. Economic importance
    i. Known time-sensitive specialist interactions with other species or abiotic factors
    j. Relationship to monitored plants
    k. Species of conservation concern
    l. Urban taxa
    m. Sensitivity to climate change
    n. Potential to stimulate partnerships
IV. Optional but desirable characteristics of monitored taxonomic groups
    a. Taxonomic representation
    b. Geographic representation
    c. Ecological representation
    d. Temporal diversity of phenophases

I. Characteristic required of all monitored species

- *Current knowledge about the species' natural history.* Natural history information about a species must be adequate to allow development of suitable monitoring protocols.

II. Characteristics required of species to be monitored by beginning citizen scientists

- *Ease of identification.* Selected species or genera and their phenophases (e.g., eggs, larvae, etc.) must be readily identifiable and not easily confused with similar species. In most cases, species identification should be possible without the need for capture (trapping, netting). For species that are readily identifiable throughout most of their range but that may be confused with another species in some areas, observers in areas of potential confusion should be notified. This criterion could help avoid errors in data collected by citizen scientists. Ideally species should be readily identifiable from an image, sound recording, or voucher specimen.

- *Ease of observation and data collection.* Selected species and pertinent phenophases should be readily observable without the need for specialized methods or equipment, except when needed equipment is commonly available (e.g., binoculars, mask and snorkel), inexpensive, or simple to construct. Secretive species generally should be avoided. Species that are regularly encountered during routine fieldwork are better candidates.

- *Relative abundance.* Selected species must be relatively common, such that multiple individuals can be reliably encountered during routine surveys timed for particular phenophases. This criterion will ensure that monitoring efforts are adequately productive. In the case of species of conservation concern, which often are relatively rare, the species should be locally abundant enough to be reliably encountered during surveys.

III. Optional but desirable characteristics of monitored species

- *Taxonomic stability and clarity.* Although it is difficult to anticipate future taxonomic revisions (e.g., based on phylogeographic analyses of genetic data), selected species should exhibit a high degree of taxonomic stability such that changes in species allocation are unlikely. For example, species with substantial geographic variation in morphology (or that are represented by two or more widely recognized subspecies) may not be good choices for monitoring because of the likelihood that the species will be split into multiple species. Taxonomic uncertainty could interfere with acquisition of adequate data sets for a particular species. If polytypic species are selected, then people monitoring in contact zones or zones of intergradation should be notified of the potential for taxonomic confusion.

- *Existence of legacy data sets.* Species for which there are historical data sets that could be compared to modern data should receive high priority for phenological monitoring.

Legacy data may come from independent researchers or state, federal agency databases, or citizen scientists.

- *Existence of ongoing long-term monitoring stations*. Species for which phenophases could be monitored in conjunction with existing sampling or monitoring stations that are likely to be continued over the long term should receive high priority.

- *No permits required for observation.* Species that cannot be studied without a special collecting or research permit should be avoided for citizen scientists, except in special cases. An exception is that many states require permits or licenses to use simple equipment such as small seines to sample common fish species.

- *Broad distribution.* Selected species should have a broad distribution in North America or a wide regional distribution within an ecoregion. A broad distribution will allow species to be observed at multiple locations, facilitating statistical analyses.

- *Occurrence in Alaska, Hawaii, or U.S. island territories.* To provide opportunities for participation throughout U.S. jurisdictions, some of the selected species should occur outside the contiguous United States in Alaska, Hawaii, or U.S. island territories.

- *Ecological importance*. Selected species should include some that are known to be ecologically important. Monitoring of ecologically important (e.g., keystone) species may indicate likely impacts of climate change beyond the direct effects being monitored.

- *Economic importance*. Selected species should include some that are known to be economically important (e.g., harvested species, pests, species that attract nonconsumptive recreational uses). Monitoring of these will facilitate our understanding of the economic impacts of climate change.

- *Known time-sensitive specialist interactions with other species or abiotic factors*. Species with time-sensitive specialist interactions may be particularly susceptible to environmental variation and change. Monitoring the phenology of these species will yield ecological insights and may assist with the conservation of these species and interactions.

- *Relationship to monitored plants.* Animal species selected for monitoring should include some that have ecological relationships with monitored plant species (e.g., as pollinators, seed dispersal agents, or obligate herbivores). By monitoring interacting species, we will be able to compare the independent responses of both members of the association.

- *Species of conservation concern.* Species that been identified as being of conservation concern warrant special attention because of their importance in the activities of federal and state agencies and nongovernmental conservation organizations. Examples of such species include but are not limited to the following: those listed under the U.S. Endangered Species Act (ESA) as endangered or threatened; those listed as a candidate for listing under the ESA; those listed by the International Union for Conservation of

Nature (IUCN) as critically endangered, endangered, or vulnerable; and those ranked by NatureServe as critically imperiled (G1), imperiled (G2), and vulnerable (G3).

- *Urban taxa.* At least one species per taxonomic group should occur in an urban setting. Inclusion of urban species will provide insights into urban ecology and opportunities for education and inclusion of a much greater percentage of citizen scientists, many of whom live in urban settings.

- *Sensitivity to climate change.* Monitoring should include species predicted to respond strongly to climate variability or change and those likely to be threatened or endangered by climate change. For example, species with a high degree of abiotic environmental specificity (for example, fishes with temporal spawning windows highly influenced by temperature) may be more likely to show phenological responses to climate change than widespread generalist species. Also, species with time-sensitive, specialist relationships, such as specialist plant-pollinator or predator-prey relationships, may be particularly vulnerable to climate-driven shifts in phenology.

- *Potential to stimulate partnerships*. Species that meet other criteria and also have potential to generate interest among professional or amateur membership organizations or cultural groups should receive high priority. For example, some groups such as salmonids in the Pacific Northwest present opportunities for partnering with Native Americans.

IV. Optional but desirable characteristics of monitored taxonomic groups

- *Taxonomic representation*. Within each major taxonomic group (mammals, birds, reptiles, amphibians, fishes, insects), selected species should represent multiple taxonomic orders. Additionally, to the extent possible, selected species should be representative of a broader group of species sharing the similar life history patterns.

- *Geographic representation*. The suite of selected species for each major taxonomic group should have distributions that collectively encompass most regions of North America.

- *Ecological representation*. To the extent possible, the suite of selected species should represent a diversity of terrestrial, wetland, and aquatic habitats.

- *Temporal diversity of phenophases*. The suite of selected species should collectively include phenophases that are distributed throughout different times of the year.

V. Supplemental Taxon-specific Criteria for Animals

Insects and other invertebrates

- Selected species may include those for which the egg, larval, or pupal stages are distinctive and conspicuous, even if the adult stages are not.

- For multiple-brooded species, especially butterflies, the spring brood must be easily found, or the second brood must be clearly separable from the first such that its phenology can be monitored. In the mid-latitudes, spring broods of many familiar species are rarely seen away from breeding habitats, which are not gardens, while later broods are routinely seen in gardens.

- Species that citizen scientists are encouraged to monitor should have sufficient charisma to generate interest by participants. Without this charisma, participants may lack sufficient motivation to collect and report sufficient phenological observations to detect variability and directional changes.

Fishes

- Selected species should focus on those that exhibit distinct, detectable seasonal migrations. Most fishes do not meet the general criteria for all species listed above—they are difficult to observe without specialized methodology, and phenophases suitable for monitoring are very restricted—and therefore will only be monitored by professional biologists. However, anadromous species often can be monitored at established riverine fish-counting stations and through commonly collected fisheries data.

- Appropriate species for monitoring may include the few that deposit conspicuous egg masses.

Amphibians

- Species for which eggs will be monitored should have eggs that are visible without destructive searching (e.g., in open sites, not under rocks or logs). For example, many pool-breeding salamanders and frogs are good candidates for egg monitoring, whereas terrestrial and aquatic plethodontid salamanders are not.

- Species that vocalize loudly are good candidates for monitoring. Monitored anuran species should generally have calls that are audible from a distance of at least 30 meters under normal conditions.

Reptiles

- Neonates of selected species should be readily identifiable as such. Reptiles offer a few suitable phenophases suitable for monitoring. One of these—seasonal appearance of neonates—requires that hatchlings or newborns be readily identifiable as such. For some species, inexperienced observers may have difficulty monitoring neonates.

- Species with conspicuous oviposition sites and behavior may be good candidates for monitoring. Thus, the suite of selected species probably should include certain turtle species.

Birds

- The suite of selected bird species should include some of the 139 species identified as focal species warranting heightened attention over the short term within the U.S. Fish and Wildlife Service (FWS) Migratory Bird Program's list of Birds of Management Concern. FWS will place priority emphasis on these species during the next ten years. These species are believed to meet at least one of the following criteria: (1) high conservation need, (2) representative of a broader group of species sharing the same or similar conservation needs, (3) high level of current Program effort, (4) potential to stimulate partnerships, and (5) high likelihood that factors affecting status can realistically be addressed.

- Species selected for reproductive phenology should have nest sites that can easily be found or should have distinctive, easily recognized fledglings.

- Selected bird species should represent species that migrate a variety of distances. Length of migration has been linked to phenological responsiveness to climate change. Thus it would be good to have some representatives that winter in South America (long-distance migrants), Central America and the Caribbean (mid-distance migrants), and the United States (short-distance migrants) in addition to some nonmigratory species. Long-distance migrants also include arctic nesters that winter mostly in the southern United States and farther south.

Mammals

- True hibernators should receive high priority, as these species exhibit distinct seasonal emergence (and sometimes disappearance) patterns.

- Strictly diurnal species should receive high priority because they will be easier for citizen scientists to monitor than nocturnal species.

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