Guidelines for Ethical Field Research on Rare Plant Species

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January, 2005

Field and laboratory research is critical for developing a fuller understanding of the life history, demography, habitat requirements, and management needs of rare plant species. However, the need for research must be balanced with the recognition that manipulating rare species in the wild may have negative consequences for population viability. To minimize harm to native populations while encouraging the development of sound protocols and informative field studies, we have developed the following set of guidelines for performing research on rare plants. These step-by-step guidelines are meant to help prospective researchers design studies on rare plants that are both ethically and scientifically sound. These guidelines have been developed in consultation with New England Natural Heritage Programs, the New England Plant Conservation Program's Regional Advisory Council, and in line with existing state regulations regarding experimental studies, collection, and observations of rare species.

1. Ask yourself whether a study of a rare plant species is central to your research question. Generally, studies involving rare species should generate data that are relevant to a fuller understanding of the biology of that species and should yield information that may inform effective management and conservation of that species. If a rare species is included as an ancillary taxon that addresses a hypothesis not relevant to these goals, carefully consider whether other, more common species may be substituted.

2. Perform prior research. Ensure that the proposed research does not simply "reinvent the wheel."

- Perform a thorough literature and on-line search to obtain as much existing information as possible regarding the species of interest and related ecological questions.
- If a federal Endangered Species Recovery Plan exists, obtain and carefully review this document.
- Lists of web sites and library search engines that contain information on rare plants are appended to this set of Guidelines.
- Investigate information on several species in order to obtain a selection of several alternative taxa that may be appropriate for study. The taxon or taxa that are most amenable to research can then be chosen.
- For general information on the regional rarity, distributions, ecology, and habitats of many rare plant species in New England, consult Brumback et al. 1996 (available at http://www.newfs.org/conserve/fcne.htm); the New England Wild Flower Society web site at http://www.newfs.org/conserve/plans.htm (this site also contains links to research questions related to each species); and the NatureServe website (http://www.natureserve.org/explorer/).
- Examine regional herbarium collections of the species; much valuable information on its distribution and habitats may be garnered from historical records.

3. Choose species wisely, in consultation with Natural Heritage Botanists and other field experts. The most appropriate rare taxa for scientific study are those that:

- ***Have several vigorous populations*** with tens or hundreds of plants that will provide sufficiently large sample sizes to enable statistical comparison and that will be resilient to small-scale research-related disturbance.
- ***Occur at easily accessible sites*** (preferably owned by a public or conservation entity) in which the research can be conducted without danger of vandalism, unintended damage to the plants by researchers or other visitors, or natural disturbance.
- ***Meet your research needs*** in terms size, timing, duration of flowers, fruits, plants, etc. Consider in advance if the flowers are too small for pollination experiments or if the flowers or plants are ephemeral and do not last long enough to meet your research needs.

If the first condition cannot be met, it is advisable to study populations of the plant in parts of its range where it is more secure, unless your hypothesis explicitly concerns marginal populations. Conditions may vary from year to year, and it is essential to be flexible; be prepared to devise an alternate study plan if one or more small populations are experiencing a bad year in terms of numbers or vigor.

4. Consult with a statistician while designing the studies to ensure proper replication and sample sizes, or to explore alternative statistical analyses (e.g., Bayesian approaches) that will permit unambiguous interpretation of the resulting data. Make sure that the methods are well-documented and repeatable, permitting replication in future studies; maintain detailed metadata. In addressing small or tenuous populations, it is imperative to design experiments that will permit sufficient statistical power to distinguish among alternative hypotheses. Do not wait until after the field season is over to find out that insufficient numbers or poor design will prohibit drawing sound conclusions.

5. Contact the appropriate Natural Heritage Program(s) in the states in which you intend to work to obtain a research permit. These programs have jurisdiction over listed species and are responsible for monitoring and protecting rare plant populations. ***This contact should preferably be made at least six months (and absolutely no later than two months) in advance of the proposed dates of study to provide enough time for permitting.***

- Consult with the Natural Heritage Program Botanist about the final choice of species.
- Formally request data on rare plant element occurrences by completing appropriate forms and/or a data-sharing agreement.
- Apply well in advance for a research/collecting permit.
- When the research plan is complete (see steps below for designing the research), provide a full and clear proposal to the Natural Heritage Program and the permitting agency. Include information on the intended duration of the project, expected benefits to conservation, experimental design; be forthright about limitations and constraints in data collection and interpretation. A successful research proposal will:
    - Justify the use of a rare species and explain why a less rare, related species may not be substituted
    - Justify any taking of fruits, leaves, seeds, flower, and parts
    - Prohibit or minimize removal of whole plants
    - Explain any ecological impacts of the experimentation
    - Demonstrate that impacts from visits and manipulation will be minimal
    - Demonstrate the research is technically and statistically feasible
    - Illustrate the conservation benefits of the research
    - Establish the preparedness, experience, and trustworthiness of the investigator(s)

6. Obtain landowner permission to access sites. Assuming the landowner is amenable to such studies, use this as an educational opportunity to engage landowners and/or managers in stewardship or appreciation of the plant population. Under no circumstances should research be conducted without landowner permission.

7. Design minimally invasive experiments. The objective here is to minimize damage to the viability of rare plant populations.

- Place the emphasis on observational studies rather than manipulations.
- If manipulations are necessary, use a small but informative sample size and situate experiments at the most resilient and protected sites. Minimize the number of researcher visits that must be made throughout the growing season; trampling and handling of plants, as well as collateral

damage to associated species, can have cumulative negative impacts, hasten mortality, and complicate interpretation of data.

- Mark plants as unobtrusively as possible with labels that will not weigh down plants or call undue attention to them. If a long-term study is planned, make sure markers will be easily recoverable and interpretable in future years.
- Avoid transporting any potential competitors, predators, or invasive species (weeds, herbivores, pathogens) among sites.
- Minimize disturbance of soils that can create fertile ground for establishment of invasive species. Rare plants sometimes occur in fragile (and frequently rare) critical habitats that are themselves vulnerable to erosion or other disturbance. Take into account the habitat matrix when designing the study and performing site visits.
- Minimize the possibility of introducing novel genotypes into a rare plant population. Outbreeding depression resulting from the mixing of genotypes from multiple populations is a potentially significant source of harm, in terms of reduced fitness and adaptive variation, to rare native populations. If the hypothesis does not involve mixing populations, care should be taken to prevent incidental gene flow among populations. If the experimental design explicitly demands that multiple genotypes be used (i.e., if outbreeding is the focus of the study), plants should be studied (i.e., planted in a common garden) well away from existing populations in the field. If the experimental design requires *in situ* introduction of novel genotypes from widely separated populations into an existing rare plant population, introgression should be prevented (for example, by removing reproductive structures of the introduced individuals prior to pollen release). *A plan for preventing gene flow should be explicitly stated in your research proposal.* No transplanted plants should become an established component of the *in situ* natural community.
- Plants that are propagated as part of the research should *not* be reintroduced into the wild unless they are part of a specific, approved reintroduction/augmentation plan developed in cooperation with the Natural Heritage Program Botanist. They may have been subjected inadvertently to artificial selection during *ex situ* growth, and may negatively impact the fitness of source populations.

8. Provide full documentation of the species and field site.

- Complete a field form for the relevant state's Natural Heritage Program. This information provide a valuable baseline on the status of the population before research begins.
- Coordinate with the respective Natural Heritage Programs regarding collection of voucher specimens. As a rule vouchers will not be allowed from known populations where collections have previously been made. For previously uncollected plants, provide a high-quality voucher specimen of the rare plant species to an established herbarium (listed in the *Index Herbariorum* (available at http://www.nybg.org/bsci/ih/ih.html). If plant numbers are small and do not permit a specimen to be taken, document the species fully and nondestructively with photographs of relevant diagnostic structures.

9. Be conservative in collection of seed or plant material. In general, collections should impact fewer than 10% of the individuals or the seeds of a rare plant population, and proportions should be smallest for the sparsest or most at-risk populations. Be scrupulous when harvesting not to damage plants or transmit diseases among plants. Do not to leave remaining plants in danger of further disturbance.

10. Take time to make other tangential observations that may be relevant to conservation of the populations.

- Record pollinators, herbivores, threats posed by humans, invasive species, etc., disturbance agents, abiotic variables, and other factors. This information can lead to new discoveries and completely novel ecological information available for these rare species.

11. Provide regular updates, a final report, and copies of all publications to the relevant Natural Heritage Program(s) as well as to landowners about activities and findings at sites.

- Notify the relevant Natural Heritage Program if you discover one or more new populations of the rare species as part of your research, and document these new occurrences thoroughly with field forms and vouchers.
- As soon as the field work and data analysis are complete, make a full report on findings, in scientifically accurate but clear language, to all entities with an interest in the plant (particularly landowners and Natural Heritage Programs). For multi-year studies, periodic interim reports should be filed. The implications of the research findings (and tangential observations) for conservation and management should be explicitly addressed.
- Seek publication of results in peer-reviewed scientific journals so that your findings can be shared with other biologists. Acknowledge all sources of logistical and field support appropriately in your publication.
- Natural Heritage Programs would greatly benefit from receipt of an unbound copy of any thesis or dissertation produced through the research.

12. In all publications for public consumption, maintain the confidentiality of the precise locations of rare plant populations. Many rare plant species are at risk of poaching or taking and it is important that the sites where they occur are not widely publicized. Avoid referring to tell-tale site names and highly precise GPS coordinates in publications.

13. Clean up. Minimize any long-term impacts of the study.

- Following completion of the study, all equipment, labels, exclosures, and other materials associated with the research must be removed from the field sites and the sites restored as needed, unless an explicit plan has been developed for long-term monitoring.
- The landowner or representative conservation personnel may want to inspect the site to ensure that clean-up has been successful.
- Ideally, a follow-up visit should be made to the site in the following growing season to document any lasting impacts on the population size, vigor of plants, presence of threats (i.e., invasive species introductions).

Special considerations: Minimizing negative impacts of monitoring of rare plant populations.

Regular monitoring of rare plants is an extremely valuable tool for gathering reliable data on the health of populations. Monitoring activities can inadvertently place rare plants at risk, however, and it is important to minimize potential negative impacts of the field visit. Therefore, use the following practices when monitoring rare plants in the field:

- **Minimize trampling of individual plants.** Approach the population carefully and avoid compacting soils, breaking plants, treading on seedlings, etc. Also minimize soil disturbance that can create fertile ground for establishment of invasive species.
- **Avoid transporting any potential competitors, predators, invasive species, or genes from other populations of the rare species among sites.** Before entering a new population, inspect your clothes, shoes, and hands for seeds or insects that you may have moved between sites.
- **Manually handle plants only as is absolutely necessary** to count them accurately and to obtain data on reproduction. Repeated manipulation of plants can have unintended negative effects on their growth. If plants are extremely dense or numerous, consider making multiple counts of smaller subsamples.
- **Be conservative in collection of seed or plant material.** In general, collections should impact fewer than 10% of the individuals or the seeds of a rare plant population, and proportions should be smallest for the sparsest or most at-risk populations. Be scrupulous when harvesting not to damage plants or transmit diseases among plants.
- **Take time to make other tangential observations** that may be relevant to conservation of the populations. Record pollinators, herbivores, threats, disturbance agents, abiotic variables, and other factors. This information can lead to new discoveries and completely novel ecological information available for these rare species.
- **Document** all aspects of site conditions, population status, potential and actual threats, comparisons with prior years (if known) fully in a Natural Heritage Field Form. Make sure future visitors can follow your directions to the site without ambiguity or confusion.
- **Leave as little sign of your visit as possible** so the site does not attract the curiosity of future visitors.

References and Sources of Further Information:

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TIPS FOR SEARCHING FOR INFORMATION ON PLANTS

1. Web-based library search engines: Many of these search engines should be available at local university libraries; ask your librarian.

Science Citation Index (Web of Science) -- superb for comprehensive journal coverage and providing abstracts and links to related articles

Agricola/Ovid database -- indexes many journals, with abstracts

Annual Reviews Index (http://www.annualreviews.org) -- articles from "Annual Reviews" series of journals

BioOne Database (www.bioone.org/bioone) -- Searches many environmental science and natural history journals.

Biological and Agricultural Index

Dissertation Abstracts – searchable database of PhD. dissertations covering various species

Environmental Science and Pollution Management Index – addresses management topics

J-STOR database (http://www.jstor.org) -- contains articles from past editions of numerous journals, including ecology and botany subjects, in down-loadable .PDF format

Ingenta database (http://www.ingenta.org) -- for journal articles that can be ordered on-line for a fee

Google (http://www.google.com) -- An excellent search engine for scientific topics, accessible for free on the web from anywhere.

Be sure to search for the species of interest, but also to search for the genus in general and potentially the plant family. Also, search for the particular habitat in which the species occurs, for additional information on ecology and management.

2. List of Database web sites

http://endangered.fws.gov/recovery/index.html#plans
U. S. Fish & Wildlife Service Endangered Species Recovery Plans

http://www.natureserve.org/explorer/
NatureServe Information maps and status of all listed species

http://mobot.mobot.org/W3T/Search/vast.html
Missouri Botanical Garden search engine for taxonomic information on plants

http://www.lib.berkeley.edu/EART/vegmaps.html
Vegetation Map checklist and excellent links to maps of paleo and current plant distributions

http://biology.usgs.gov/npsveg/
USGS-NPS Vegetation Mapping Program

http://plants.usda.gov/
USDA PLANTS National Database

http://www.rook.org/earl/bwca/nature/flora.html
Plants of the North

http://www.botany.org/bsa/www-bot.html
Botany Related WWW sites from the Botanical Society of America

http://ucjeps.berkeley.edu/bryolab/greenplantpage.html
The Deep Green green plant phylogeny web site from U. C. Berkeley

http://tncweeds.ucdavis.edu/esadocs.html
Information on invasive species and their impacts from The Nature Conservancy

http://conbio.net/scb/
Society for Conservation Biology web page, references and resources on conservation science

http://www.rbgkew.org.uk/conservation/recplan.html
Kew Botanical Garden list of references on the science of reintroduction, restoration, and recovery plans.

http://rathbun.si.edu/bcn
Searchable database of over 15,000 references to literature on conservation biology, compiled from Current Contents, museum libraries, etc.

http://www.qc.ec.gc.ca/faune/biodiv/en/recherche/especes/vasc_plants2.html
Environment Canada web site showing maps of the distribution of many rare plants in the St. Lawrence River area and other regions.

http://lcweb2.loc.gov/ammem/gmdhtml/cnsvhome.html
U. S. Library of Congress Conservation and Environment Maps.

http://www.bonap.org/
Kartesz Synonymized Checklist of the North American Flora, with maps.