

Supplemental information

Integrating public engagement to intensify pollination services through ecological restoration

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Supplementary material of Integrating public engagement to intensify pollination services through ecological restoration

Glossary

Active restoration. Strategy of ecological restoration in which many management techniques are employed. Examples include selecting and planting seeds and/or seedlings.

Ecosystem services. Benefits and goods provided by nature to people. Ecosystem services are classified into supporting, regulating, provisioning and cultural services.

Ecological intensification and native pollination intensification. Ecological intensification is based on the replacement of anthropogenic inputs and expansion of cropland area by biodiversity-friendly practices and provision of ecosystem services to enhance agricultural productivity and farmers' livelihoods. Native pollination intensification is a specific type of ecological intensification based on using biodiversity-friendly practices to improve pollination services provision to enhance agricultural productivity and farmers' livelihoods.

Functional complementarity. When two or more species perform distinct functions or complement each other in a specific function. For example, two plant species blooming in distinct periods complement each other in terms of sustaining pollinators in the area.

Landscape composition and configuration. Composition refers to the amount of each patch type in a landscape. Configuration also incorporates the location of each patch type in a landscape.

Legal opportunities for restoration. Refers to each government's existing laws and standing rules (local, regional or national level) that contribute, enforce or facilitate restoration initiatives.

Mosaic restoration. Type of ecological restoration that seeks creating diverse managed landscapes. Mosaic restoration will often result in landscapes composed of natural areas, protected areas, and distinct types of croplands.

Multidimensional valuation. Valuation of Nature's Contributions to People through multiple capitals: natural (environmental and physical) and socioeconomic capitals.

Nature's Contributions to People. Positive and negative contributions of nature to the quality of life for people. The Nature's Contribution to People (NCP) framework abandoned the previous classification of ecosystem services in the view that many NCP fit into more than one category.

Passive restoration. Strategy of ecological restoration in which low impact management techniques are employed.

Pollination and pollination services. Pollination refers to the process of pollen transport from the male reproductive organs of a flower to the female reproductive organs of a flower, which may result in fruit and seed production. Pollination services are the benefits to crop production (resulting in crop yield) provided by pollinators.

Pollination demand. Demand for pollination services in a locality. Pollination demand is often inferred as the level of crop dependence on animal pollinators in a locality.

Pollination flow. Flow of pollination services between localities. Pollination flow is often inferred as the connectivity and potential movement of pollinators between areas of pollination supply and areas of pollination demand.

Pollination friendly-practices. Management practices that promote and ensure foraging, reproduction, and shelter habitat for pollinators. They also include integrated pest management and site monitoring over time with pollinator inventories.

Pollination provision. Actual provision of pollination services in a locality. Pollination provision can be measured *in situ* by recording pollinator activity and impact on crop yield in a locality. Pollination provision is often inferred as the association between demand, flow and supply.

Pollination shortage. Yield gap due to a lack of sufficient pollination services in a locality. Pollination shortages can be measured *in situ* by comparing crop yield in the absence and presence of pollinators. Also referred to as 'pollination deficit'.

Pollination supply. Potential provision of pollination services in a locality. Pollination supply can be measured as pollinator abundances *in situ* or inferred through spatially-explicit landscape models.

Public engagement. Process of exchanging scientific information between specialists and non-specialists. It is often a two-way process, and one of the goals is to foster implementation of evidence-based actions by the non-specialist public.

Shared demands. Problems or needs related to implementing evidence-based actions shared by distinct sectors.

Transversal actions. Practices related to implementing evidence-based actions that require the involvement of distinct sectors.

Two-way approach. Process of creating and assessing scientific information between academic and non-academic sectors. It is often related to knowledge co-production.

Vegetation deficit. Amount of vegetation needed to support biodiversity conservation and the provision of NCP in a locality. Depending on the country, specific legislation may regulate the amount of vegetation required in a landscape.

Appendix A - Complete Box 1.

Complete Box 1. Table relating all actors important in Bragança Paulista (BP), their rules-in-use (i.e., relationships that define interactions in the social arena in the Institutional Analysis and Development framework) and their contribution to the dialogue of shared demands (i.e., common needs and goals in the Public Engagement framework).

Table 1

Actors	Rules-in-use	Direct contribution to the dialogue of shared demands
Small farmers	Internal community rules of space and resource use; Local dynamics defined by subsistence; Acquired knowledge about resources management and use; Local custom and uses; Higher-level organization (associations); Access to subsidies and funding; Power dynamics with local government and big farmers; Legal restrictions on land use.	Guide products (based on farmers' experience/demands) to delimit issues and problems; knowledge of internal rules of land use management
Big farmers	National and international market demand and supply; territorial agreements; Access to public power institutions; Hiring of specialized labor and consultancy; Power dynamics with local and federal government; Legal restrictions on land use.	Delimit issues (guided by demand of increased productivity); situate needs to conciliate biodiversity conservation and agricultural productivity
Agricultural technicians	Specific producer demands; interlocution with local government; legal restrictions on land use.	Identification of issues and problems; mediation of rules-in-use and dialogue with farmers
Rural Extension Agencies	State demands; Specific producer demands; interlocution with local government; legal restrictions on land use.	Identification of issues and problems; mediation of rules-in-use and dialogue with farmers
Associations and Cooperatives	Internal community rules of space and resource use; Local hierarchies; Power dynamics with local government and big farmers; Legal restrictions on land use.	Identification of issues and problems; Application of rules and sanctions; Direct access to local power dynamics

NGOs/ Third sector	National and international agendas on biodiversity conservation and restoration; Legal restrictions on land use.	Implementation of evidence-based solutions for pollination services and restoration
Municipality Environmental Secretariat	State demands; Power dynamics with small and big farmers; Interaction with associations and cooperatives; Legal restrictions on land use.	Implementation of evidence-based solutions; viability of installed capacity for restoration; implementation of governance models
State Environmental Secretariat	National demands; National and international market demand and supply; Power dynamics with small and big farmers; Legal restrictions on land use.	Implementation of evidence-based solutions; viability of installed capacity for restoration; implementation of governance models
Scientists	Scientific demands; internal academic rules; knowledge hierarchies with small and big farmers	Evidence-based problems and solutions; multisectoral communication
Public Policymakers	National and international market demand and supply; National and international agreements on biodiversity conservation and restoration; Power dynamics with associations and cooperatives; Power dynamics with small and big farmers;	Public policy decisions; financial support; implementation of governance models

Appendix B - Complement of Box 2.

In this case study, we mapped important biophysical context variables (in the IAD) at the municipality-level. The full application of the IAD will also uncover how stakeholders (Actors in Box 1) interact and share common pool resources (e.g., via Rules-in-use, Box 1). The concepts of public engagement frameworks will also help define the shared demands of each stakeholder involved in restoration efforts (Shared demands, Box 1). For instance, municipalities with a higher vegetation deficit will present a shared demand between farmers, NGOs, scientists, and governance bodies in compliance with legislation to achieve pollination service and biodiversity conservation. The IAD will give information on which stakeholders access resources for restoration (e.g., big farmers via association with the third sector) and which do not (e.g., small farmers with no financial resources to conduct active restoration). All these pieces of information can then be used together to design public engagement strategies. In this hypothetical case, big farmers may engage via incentives to cooperate with the third sector in restoration. Small farmers may engage via technical and financial support to conduct restoration with academia and governance bodies.

Appendix C - Complement of Box 3.

Table containing all plant species potentially recommended for restoration actions to enhance pollination intensification in Bragança Paulista (BP). Plant species were first selected via the tripartite network based on crop-pollinator-native plant interactions. Then, we used as criteria

the number of crop pollinators shared with crops planted in BP; the peak bloom (complementary to crop bloom) as a means of avoiding competition for pollinators; and availability in nurseries to guarantee a rapid implementation in current restoration projects.

Table 2

Plant species	Shares pollinators with	Number of crop pollinators	Peak bloom	Availability in nurseries
<i>Ageratum conyzoides</i>	Chayote, Coffee, Eggplant, Zucchini	2	January; June-July	no
<i>Andira fraxinifolia</i>	Chayote, Coffee, Eggplant, Zucchini	1	August	no
<i>Cabrlea canjerana</i>	Chayote, Coffee, Eggplant, Zucchini	1	September-November	yes
<i>Casearia sylvestris</i>	Chayote, Coffee, Eggplant, Zucchini	4	July-September	yes
<i>Cedrela fissilis</i>	Coffee	1	September-November	yes
<i>Ceiba speciosa</i>	Chayote, Coffee, Eggplant, Zucchini	4	March-May	yes
<i>Croton floribundus</i>	Chayote, Coffee, Eggplant, Zucchini	6	October-December	yes
<i>Croton lundianus</i>	Coffee	1	October-November	no
<i>Cupania vernalis</i>	Chayote, Coffee, Eggplant, Zucchini	5	May-August	yes
<i>Jaegeria hirta</i>	Coffee	1	March-April	no

<i>Luehea divaricata</i>	Chayote, Coffee, Eggplant, Zucchini	7	November- January	yes
<i>Machaerium nyctitans</i>	Chayote, Coffee, Eggplant, Zucchini	4	February- April	yes
<i>Manihot grahamii</i>	Coffee	1	November- December	no
<i>Marsypianthes chamaedrys</i>	Chayote, Coffee, Eggplant, Zucchini	1	January- March	no
<i>Orthosia urceolata</i>	Chayote, Coffee, Eggplant, Zucchini	4	March	no
<i>Piptadenia gonoacantha</i>	Coffee	4	October- December	yes
<i>Prunus myrtifolia</i>	Chayote, Coffee, Eggplant, Zucchini	5	April	yes
<i>Pyrostegia venusta</i>	Chayote, Coffee, Eggplant, Zucchini	4	May-August	yes
<i>Roupala montana</i>	Chayote, Coffee, Eggplant, Zucchini	5	June- September	yes
<i>Didymopanax vinosus</i>	Chayote, Coffee, Eggplant, Zucchini	11	June- September	yes
<i>Schinus terebinthifolia</i>	Chayote, Coffee	2	February- March	yes
<i>Senna rugosa</i>	Chayote, Coffee, Eggplant, Zucchini	3	March-April	yes
<i>Sinningia allagophylla</i>	Coffee	1	October- November	no

<i>Solidago chilensis</i>	Chayote, Coffee, Eggplant, Zucchini	3	March	no
<i>Stylosanthes scabra</i>	Chayote, Coffee	1	April	no
<i>Zanthoxylum rhoifolium</i>	Chayote, Coffee, Eggplant, Zucchini	2	October	yes
