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SeasonWatch: Tracking Trees Through the Seasons

Abstract

The paper explains how flora changes during the year and points out that phenology of plants and animals can tell us a lot about our environment. It points out that the phenology (study of cyclic events) of plants also affects the animal phenology. The paper presents data received from volunteers from a survey in a segregated manner from across India.

Introduction

Phenology

Events such as flowering, fruiting, appearance of new leaves in plants, and hibernation and migration in animals, are cyclic. Phenology is the study of the timing of such cyclic events in relation to seasons and climate. For instance, every year, the Red Silk Cotton tree *Bombax ceiba* flowers in the cool dry season between December and February, and the Indian laburnum tree *Cassia fistula* flowers in the hot dry season between April and May. Although trees of these two species flower at different times compared to one another, they do so in sync with other trees of their own species. The Pied cuckoo, a handsome black and white bird, is believed to be the harbinger of rains in India. This bird becomes more common in some parts of India just before the monsoon arrives, and farmers use the sign of its appearance to plan their crops accordingly. Understanding the phenology of plants and animals can tell us a lot about our environment.

Seasonal Changes in Plants

In temperate parts of the world, flowering in trees is often induced by increasing temperatures immediately after the winter season. Some iconic temperate species such as the Japanese cherry blossom tree *Prunus jamasakura* have been blooming so predictably, at the same time each year, that humans have created entire cultural contexts around these events. Records on the timing and intensity of blooming in cherry blossom trees have existed for 1200 years now! Other temperate species, like the Oak tree *Quercus robur*, put out new leaves as soon as there is a desirable increase in temperature. We have very few, comparably documented changes in plant species of the tropical regions. In India especially, because of differences in temperature and monsoon regimes, even the same species of trees show varied behaviour across different regions. Local anecdotal evidence may hint at predictable patterns of change in culturally or economically valuable trees. Some of our cultural festivals such as Vishu (Malayali new year) in Kerala, Ugadi in Karnataka, and Holi in northern India are associated with the flowering phenology of Indian Laburnum *Cassia fistula,* Neem *Azadirachta indica,* and Flame-of-the-forest tree *Butea monosperma*, respectively.

Tree Phenology Affects Animal Phenology

Plants are primary producers and the lives of all consumers are dependent on them. The

seasonal changes that occur in plants are thus, valuable for all animal life dependent on the different emergent stages of plants. Take the example of crops - they are sown at a certain time of the year and harvested at another - both predictable, cyclic, and directly affect human beings. Similarly, the appearance of leaves, flowers and fruits on plants affects the life cycles of other species dependent on these for food and shelter. Let us consider the Oak tree again - as temperature rises at the end of the winter season, the tree puts out new leaves in a sudden spurt (called bud-burst). This bud-burst coincides with the hatching of the larvae of the winter moth which feed on the newly emerging leaves. The larvae, in-turn, are food for chicks of migratory insectivorous birds. Thus, the life cycles of winter moths and migratory insectivores are both linked to the phenology of the oak tree.

Climate Change Affects Tree Phenology

From scientific studies, there is enough evidence to suggest that phenological changes, especially in temperate species, is mostly driven by seasonal changes in temperature. A direct consequence of ongoing climate change due to global warming, has been the advancement or elongation of warmer seasons (like spring and summer). Consequently, plants have been leafing and flowering earlier and earlier each year. This has direct consequences, not only for the plant species, but all other species dependent on the plant. Take again, the example of the oak tree. With warming climate, bud-burst has advanced by several days. In order for the winter moth larvae to survive, they now need to hatch earlier out of their eggs. In order for migratory insectivores to be able to feed on these larvae, they need to migrate earlier than before or starve. These cascading effects of climate change on plant and animal phenology are more apparent in tightly-linked food chains. In the tropics, there is not enough information about such links between plant and animal phenology, much less the effects of climate change on these links. In short, we need more information about these links from lesser-known and unexplored regions of the world.

SeasonWatch program

The Need for Phenology Data

Maintaining phenology data can help us detect changes taking place in our local environment with respect to those occurring globally, as well as over time. Scientists can use the data to study the pace of such changes and predict future changes. Recording phenology data on plants and animals can help us understand which species are at risk due to climate change and which ones are adaptable. In addition to recording changes taking place in the lives of plants and animals, scientists also use phenology data to explore which climatic conditions such as temperature, precipitation or water availability etc. maybe responsible for these changes. This is valuable for not only local communities such as farmers and planters, who are directly affected by the changes in the plant and animal life around them that impact pollination, crop yield etc, but also us, as the changes in our environmental conditions such as water availability and temperature directly affect our lives.

Meticulously kept record of the Japanese cherry blossom over 1200 years, as we saw earlier, have shown that the blossoms that flowered between 10th and 20th April historically, have started flowering before 10th April in the last 50-60 years. And these changes coincide with the warming in our climate. Changes are happening in our environment and we may hear about these changes on television or read about them, making them appear distant and at times difficult to relate to. Phenology data, particularly in the tropical countries, is scarce leaving a gap in our understanding. Keeping phenological records on the lives of

plants and animals, provides an opportunity to observe these changes first hand, giving us a better understanding of what is happening in our own environments. However, the scale at which these data are required is often not attainable in a small research lab or by a few scientists working by themselves. This is where Citizen Science can come to the rescue!

Citizen Science

Citizen science is an umbrella term used for a variety of scientific projects where members of the public and scientists work together and co-create knowledge around a scientific topic or issue. Citizen volunteers help collect data over vast regions such as at the level of a country, or across the world which is not possible for an individual or a small group of scientists to do. The tools of scientific enquiry, as well as the information thus generated is co-created by and is available to a wider community within our society, instead of being restricted with a few scientists. A list of various Citizen Science projects is available onwww.citizenscience.org and www.scistarter.com. Projects such as eBird, see thousands of birders across the world, birding and uploading their observation into a common database every day, collecting valuable information on bird species distribution. Other projects such as 'iNaturalist' and 'India Biodiversity Portal' help collect data on the distribution of a whole range of plants and animals, globally and in India, respectively. While the above projects help document life around us, they usually require short-term engagement. Citizen science projects based on phenology usually require long-term engagement. For instance, the USA National Phenology Network, is dedicated to collecting long-term phenology data on the lives of hundreds of plants and animals in the USA. SeasonWatch is a similar project in India.

Season Watch

Started in 2010, SeasonWatch is a citizen science project monitoring phenology of over 100 common tree species across the country. SeasonWatch has the dual goal of taking children closer to nature, while gathering valuable scientific data on the phenology of trees. Participants - school children and interested citizens - observe trees in their neighbourhoods and report the appearance and quantity of flowers, fruits, and leaves. Contributors can adopt a tree for long-term monitoring or report quick, one-time observation on trees. The data help us understand patterns in flowering, fruiting, and leafing in tree species between different places, as well as from one year to the next. Although, anyone can participate, the bulk of the information is collected and contributed by school children. With the help of their teachers, students are observing and recording phenology data on trees in and around their schools, and in the process, learning about the changes in their own environment (see BOX for more on how you can participate as a school).

BOX: How to participate in SeasonWatch if you are a teacher

If you are a teacher interested in knowing how trees change with the seasons and wish to use this knowledge as a tool to teach children about trees, seasons and ecology, here are three easy steps to start:

1. Register with a valid email ID as a user with SeasonWatch at the website (www.seasonwatch.in) or using a freely downloadable Android app on your smart phone.
2. Once registered, you can register one or more trees for observation (see species list here: www.seasonwatch.in/species.php). You will need to provide some basic information about this tree - such as the species name and it's location. Once a tree is registered, you can assign children to observe the tree every week.
3. Upload information: children will be expected to observe the leaves, flowers and fruits on the registered tree and say whether they are absent ('None') or pres-

ent in less than 1/3rd of the tree canopy ('Few') or present in more than 1/3rd of the tree canopy ('Many'). Children can record this information on the SeasonWatch observation sheets. The observations can then be digitised by uploading on the website or phone app. Digitised data is stored on a database from where information on tree phenology is accessible to anyone interested in exploring and analysing these patterns (www.seasonwatch.in/explore.php).

Using SeasonWatch as a Teaching Tool

The act of observing trees can provide opportunities to observe ecological interactions in nature. The following ideas can be demonstrated using SeasonWatch observation protocols:

- IDEA 1 - Plants are producers, different animals feeding on plants are consumers: Go outdoors and encourage students to look at trees carefully - are the leaves entire? Does it have flowers? What kind of fruits do trees make? If a leaf looks eaten, look for the animal which could have caused this damage. Observe other animals that are feeding on flower nectar or fleshy fruits of trees. What are animals getting from eating parts of the tree? Thought experiment - What will happen if trees did not produce leaves, flowers or fruits?
- IDEA 2- Environment affects living things: Encourage students to adopt a tree and look at it often. Notice (or measure if possible), the changes in temperature and rainfall every time their tree shows a dramatic change in leaves, flowers or fruits. Does change in the environment reflect in a change in the tree? Thought experiment: What would happen to trees if 365 days in a year the temperature and rainfall stayed the same?
- Participate as your school in our quarterly bioblitz events – SeasonWatch Tree Quests - held in March, June, September and December by making one-time observations on as many trees as possible. It is an exciting challenge for children and a fun national-level race. Data from these events tell us about how trees change through 4 seasons. Use graphical outputs from these events (available in event report and on the website) to teach about seasonality in trees Contact: email - sw@seasonwatch.in, WhatsApp: +91 7349567602, website: www.seasonwatch.in, bioblitz: www.seasonwatch.in/events.php

Insights from Season Watch Participation

Till date, over 60,000 trees have been observed by students from 680 schools and by 900 individuals across India. Of these, 10,526 trees are registered for long-term observations, that is, participants adopt and observe the same tree for months, sometimes years. These repeated observations help us understand how the same tree behaves over months and years. The remaining 50,000 odd trees have been observed only once. These quick observations, gathered during bioblitz events (known as SeasonWatch Tree Quests, see BOX) capture snapshots of tree phenology across the country, giving an idea of how trees behave from one place to another. In all, there are over 3,00,000 observations in the SeasonWatch database including repeated and one-time observations. These are extremely valuable as they provide information on how tree phenology behaves over space and time.

Phenology Patterns from SeasonWatch Data

Since 2014, enough data has been collected to explore the phenology of a few very common species of trees, especially from the state of Kerala from where we also see maximum participation. Jackfruit tree *Artocarpus heterophyllus* is the most observed species from this state. We know from data collected

from SeasonWatch that, on an average, most Jackfruit trees have ripe fruits in the month of April and that new leaves are present almost throughout the year. Mango *Mangifera indica* is another widely observed tree; it flowers from December through March and fruits the most in the month of April in Kerala. In December 2018, countrywide observations on Mango showed that while in the south it had already started flowering and fruiting, the north of the country mostly had trees that had just about put out new leaves. Teak, Neem, Tamarind and Amla are some of the other common, most observed trees.

Data on some species seems to show evidence for advancing in some aspects of tree phenology. For example, the Indian Laburnum tree, which is expected to flower coinciding with the Malayalam new year of Vishu, has anecdotally been observed to flower at other times of the year. Data from SeasonWatch indicates that in Kerala, a small percentage of trees of this species were always flowering in the past 4 years and that peak flowering (when a large percentage of trees were in full flower) was happening many days before Vishu. SeasonWatch data thus provided quantitative evidence in favour of a pattern that people had been noticing in their neighbourhoods! If there is indeed a shift in the flowering time of Indian Laburnum trees, what environmental variables are causing this and what consequences does the shift have on insects, birds and mammals dependent on this tree - are the next pertinent questions to ask.

Collaborate with SeasonWatch!

In the coming years, we want to work towards gathering comprehensive phenology data across space and over the years for many more common species across the country. We also plan to capture how various species are responding to the changes in climatic conditions. Currently, a majority of the information comes from a handful of states, such as Kerala, Tamil Nadu, Meghalaya, Karnataka, Andhra Pradesh, Orissa, West Bengal, Uttarakhand. Trees from the rest of the country remain unreported. This creates large information gaps across India which SeasonWatch endeavours to fill in the coming years.

To this end, we seek the help of educators everywhere to take SeasonWatch to interested children in their schools. Hundreds of school students have watched trees in their school campuses each week, and learnt something new about their environment in doing so. Teachers of some of these students have reported positive attitudes towards trees, and curiosity about the plant and animal life around them. As we work on formalising an education framework to understand trees better, we invite educators to collaborate with us on this exciting scientific endeavour.

References & Bibliography

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