Chapter 5
Tree Phenology Networks

In recent years, the involvement of the general public and school students in monitoring the environment has gained popularity. This has been achieved with the development of 'citizen-science' initiatives. Citizen-science networks are being used extensively in phenology research and provide valuable data to determine climate change impacts. These networks also help raise awareness among the non-scientific community of potential environmental threats. Nature enthusiasts and farmers have been following the phenology of various plants for the last few centuries. However, many of these data remained as the private property of the collectors themselves or totally lost. Recently, as studies on climate change have been taken up by many organizations, much of the phenological data are getting reassembled and wide networks of volunteer observers have been formed. With the wide use of internet, much of these data are available for the user.

The California Phenology Project (CPP) is one such network project developed with the purpose of public education and outreach along with sound scientific practices and outcomes to inform natural resource management for 19 National Park Service units in California, USA. The primary goal of the CPP is to organize and implement integrated phenology monitoring projects under a collaborative science framework across California parks and partners. The project is expected to assess how phenology can best be used to monitor the response of natural resources to climate change across California's diverse landscape. The project also intends to identify and summarize legacy phenology datasets in California to provide a historical context for current monitoring and educational activities (see http://www.nps.gov/lavo/naturescience/phenology.htm).

Another wide network on phenology is the USA National Phenology Network which promotes broad understanding of plant and animal phenology and its relationship with environmental change. The Network is a consortium of individuals and organizations that collect, share, and use phenology data, models, and related information (see https://www.usanpn.org). Similarly, there is a citizen science program coordinated by the Appalachian Mountain Club including tracking seasonal changes of plants and animals along the Appalachian Trail, from Maine to

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Georgia and also documenting alpine flowering and fruiting times on high peaks in the New England area (see http://newengland.stewardshipnetwork.org/citizen-science/amcs-mountain-watch-phenology-program). "Project Budburst" is another very enthusiastic programme spread over the entire USA. This is a national field campaign designed to engage the public in the collection of important ecological data based on the timing of leafing, flowering, and fruiting of plants. Project BudBurst participants make careful observations of these plant phenophases. Thousands of people from all 50 states in the USA are participating in this project. Project BudBurst began in 2007, and the observation data is available for downloading and analysis (see http://budburst.org). The New York Botanical Garden's *Citizen Scientist Phenology* programme has been monitoring the phenology of native plants in the forest for nearly a decade. The Garden has partnered with the National Phenology Network to develop a long-term dataset that will show how a changing climate is impacting native plants in the forest.

New Zealand Plant Conservation Network is another network based in New Zealand in which any observer can report the phenophases of any plant in New Zealand. Their website gives help for identifying any plant in the country (see http://www.nzpcn.org.nz).

The Woodland Trust in the United Kingdom, apart from helping in conservation of native plants in the country has a programme named 'Nature detectives' mainly enthuse the youth in seasonal changes happening to plants, phenology (see http://www.naturedetectives.org.uk). The Swedish National Phenology Network (SWE-NPN) is collaboration between universities, governmental agencies, and volunteers. Their main goal is to collect, store and provide long-term environmental assessment data on phenology. SWE-NPN is also aiming to be a meeting place, where agencies and organizations are welcome to initiate and develop ideas related to phenology. SWE-NPN collaborates with national phenology networks in other countries and is a member of the Pan European Phenology Project (PEPP) (see http://www.slu.se/en/collaborative-centres-and-projects/swedish-national-phenology-network).

Ireland's National Phenology Network (IE-NPN) was established to coordinate phenological activity throughout the country. The number of designated phenological recording sites was expanded to include International Phenological Gardens (IPG) sites and a series of native species gardens. The combined networks will enable comparison of the timing of phenological phases of a range of trees at a European level using the IPG data and at a national level using the native species. Ireland's National Phenology Network is also the contact point for collaboration with other similar networks around the world, such as the national phenology networks in Sweden (SWE-NPN) and the USA (USA-NPN), Nature's Calendar in the UK and many others. Research activity is a key focus of IENPN and a number of historic datasets have been identified and analyzed in relation to temperature variables to determine if global warming has had an impact on plants, birds and insects in the Irish environment. An advance in the timing of key spring phenophases of plants (leaf unfolding of a range of trees has occurred since the 1970s and this can be attributed, at least in part, to rising spring temperature).

The German Weather Service has a phenological network with data going back to the year 1530. A comprehensive list of phenology networks around the world is given by the Potsdam Institute for Climate Impact Research (see http://www.pik-potsdam.de/~rachimow/epn/html/frameok.html) which is supported by the European Phenology Network (EPN).

In India also, a couple of networks have started recently which are aimed at recording phenophases of many tropical trees (see http://treecalendar.org by the Kerala Forest Research Institute and the National Centre for Biological Sciences and http://www.seasonwatch.in).