A report on

Line-transect sample surveys to estimate Peafowl abundance in Shivaji University campus

By

Shashibhushan Mahadik
Professor
Department of Statistics

Shivaji University, Kolhapur

Indian peafowl

The native range of the ornamental bird Indian peafowl or blue peafowl is the Indian subcontinent. The population of the species is reasonable in India, Nepal, and Sri Lanka, while that is rare in Pakistan, Bhutan, and Bangladesh. It has been introduced in many other parts of the world and has become feral in some areas. It is believed to cause some ecological and social problems in most of the countries where it is introduced by humans. However, in its native range, the species is an important part and parcel of local biodiversity and provide a role as a part of terrestrial food chains, consuming various invertebrates, small vertebrates, and plant matter, and being consumed by larger animals and predatory birds.

Indian Peafowl

The Indian peafowl is a ground dweller and is found in moist and dry deciduous open scrub forests containing some tall trees or on land under cultivation with adequate sites for dust bathing and lekking, a phenomenon in which peacocks (that is, males) congregate in open areas for displaying to attract peahens (that is, females). Once peafowl settle on a place to live, they generally do not go away far. They prefer sites close to reliable water access, often riverbanks. They are omnivorous and forage for berries, grains, fruits and also prey on snakes, lizards, and small rodents. They feed on small snakes but keep their distance from larger ones. Their loud calls make them easy to detect, and in forest areas often indicate the presence of a predator such as a tiger. They forage on the ground in small groups and usually try to escape on foot through scrub and avoid flying, though they fly into tall trees to roost. They usually emerge from cover early in the mornings and evening to drink from water bodies and forage for food. They tend to stay in cover during the heat of the day. Peafowl roost in groups during the night on tall trees. They arrive at dusk and call frequently before taking their position on the roost trees.

Peafowl abundance estimation in India: current status and need

The reliable estimates of the population size of Indian peafowl and their spacial distribution are not available due to lack of complete information. The species is listed as of ‘Least Concern’ by the International Union for Conservation of Nature (IUCN). However, studies in India shows that the species is becoming locally extinct from several parts of its native range due to numerous reasons such as habitat conversion, changes in the cropping pattern, poaching for feathers and meat, degradation of habitats due to pesticides, drought conditions, increased civilization, etc. It is high time to undertake periodic field surveys driven by appropriate scientific methods in the whole country to get reliable estimates of the current population size and geographical distribution of the species throughout the country

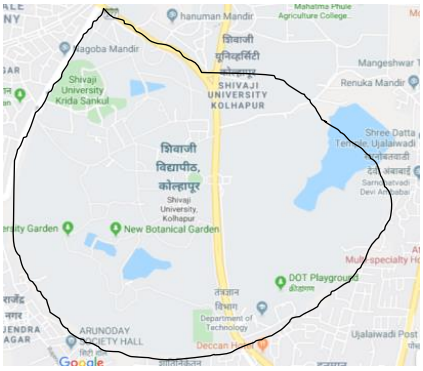
and to quantify the trend in those estimates over the time, so that effective conservation plans can be undertaken. Some of the states including Himachal Pradesh, Uttarakhand, and Gujarat have already initiated statewide surveys.

Estimating species' abundance and distribution is crucial in ecology. If we could establish a precise statistical relationship between a species' abundance and some environmental covariates, then the species can be used as an indicator of specific environmental conditions. Long-term and in-depth studies of species' distribution and its habitat can produce such models. Recent studies about the habitats of feral Indian peafowl on Kangaroo Island in South Australia resulted in knowing that the presence of peafowl at a particular place on Kangaroo Island highly depends on three important environmental covariates, namely, the dominant habitat type of that place, its distance from grassland, and the percentage of native vegetation in that place. Some other studies reveal that the presence of peafowl at a particular place also highly depends on the distance of this place from a water body.

Peafowl abundance in Shivaji University campus

In recent years fortunately there is noticeable growth in peafowl abundance in Shivaji University campus. Nowadays, especially during August to October, the university peafowl are attracting environmental and other visitors to watch their amazing groups. It is thrilling to experience the heavenly beautiful scenes of peacocks dancing with their erected and fanned out train-feathers on the adorable background of semi covered natural greenery with little picks and troughs. The ever stirring inhabitance of the birds stimulated the author to estimate there abundance in the campus.

Shivaji University has the huge campus of 3.45 km^2. It is partially covered with tall trees, scrubs, and contains adequate grassland and open area. Such favorable condition for peafowl inhabitance is being there since long time. However, the substantially increased peafowl inhabitance has emerged during last 7-8 years. This might be the effect of proactively developed rich livestock water reservoirs in the campus during last 17-18 years. The significant inhabitance of peafowl has made sightings of snakes rare.



Map of Shivaji University campus
(The boundries shown are approximate)

A water reservoir in the university campus

Line-transect sample surveys in the campus

The line-transect sample surveys were organized in the month of March in years 2017, 2018, and 2019 to estimate peafowl abundance in the university campus. A group of about 55 volunteers including teachers, research scholars, and post-graduate students of Department of Statistics of the university participated in these surveys.

Line-transect sample survey volunteers 2019

Line-transect sampling is the most commonly used technique for estimation of biological population abundance. A line-transect is a segment of a straight line whose endpoints touch the boundaries of the field. In a line-transect sample survey, a set of parallel line-transects is chosen at random and observers traverse along them searching for the species whose abundance is to be estimated. The moment at which an individual (or a cluster) of the species is sighted, the observer measures or estimates two things, one is his distance from the sighted individual (or from the center of the sighted cluster) and the other is the angle between the line-transect and the line passing through the observer and the sighted individual (or the center of the cluster). These distance and angle, called radial distance and sighting angle, respectively, are then used to compute the perpendicular distance of the sighted individual from the line-transect. The frequency distribution of the perpendicular distances of all the sightings provides a way to estimate the abundance of the species.

The precision of an abundance estimate highly depends on how accurately the observers estimate the radial distances and sighting angles. Generally, a range finder is used in line-transect sample surveys for estimating the radial distances. However, we planned to apply some innovative idea for this purpose. A lot of experimentation was done to devise a method of estimating the radial distance accurately. We exercised various ideas in the actual field number of times and finally found that the method of triangulation works well in providing sufficiently accurate estimates of the radial distances. To apply this method, we created a simple instrument by tying two plastic pipes, each of 1 inch diameter and about 15 inch long, to the ends of a 10 meter long string. We call this instrument the distance measuring instrument.

Distance measuring instrument

Each year we conducted three to four surveys along the different sets of line-transects. The volunteers were provided sufficient training and pilot surveys were conducted each year before the conduct of actual surveys in order to get an idea about the field conditions and to minimize procedural errors. In year 2017, we could also recognize some procedural errors during the analysis of the actual surveys and hence could not obtain precise abundance estimate.

Pilot survey

Training to volunteers

In an actual survey, the volunteers were divided into seven teams each consisting of seven-eight members. Seven parallel line-transects were chosen at random. The average length of the line-transects was about 1.2 km.

A survey team

The sets of line-transects chosen for the surveys

On the day of the survey, all the volunteers gathered before the sunrise in a central place near the administrative building of the university. The seven teams were assigned randomly to the seven line-transects to traverse along them. Each team was provided a hard copy of the map of the line-transect assigned to it, a distance measuring instrument, and recording sheets.

Gathering of the teams just before starting the survey

Then, all the teams moved towards the starting points of the line-transects allotted to them and started traversing along them simultaneously at around 7.00 AM. Each member in a team had been assigned a specific task while traversing along a line-transect and accordingly they were designated. A team had a team leader, a pilot, two designated observers, two readers, and a recorder. The job of a team leader was to maintain coordination among the team members and to be in communication with the survey leaders. A pilot was the team-member who remained ahead of the team while traversing. His job was to maintain the traversing along the line-transect as accurately as possible with the help of the hard copy of the map, a compass, and the GPS enabled traversing system along a straight line, which was developed for the chosen line-transects with the help of Department of Geography. He was not supposed to observe the peafowl. The rest of the team was aligned in a row and followed the pilot calmly along the line-transect keeping a distance of about 15 meter from him and observing the presence of peafowl on the line and on its both sides. When somebody could sight a bird, traversing was stopped and the two designated observers, who were carrying the instrument, maintained the distance between them such that the string joining the pipes remained tight and then simultaneously aimed at the bird (or most frequently at some static object close to it) through the pipes. Then the readers put the smart phones equipped with a compass app on the pipes and measured the degrees of the sighted bird from the designated observers. Finally, the recorder recorded the degrees and the traversing is continued. This procedure is followed until the team reached the end-point.

A team traversing along a line-transect

Measurements for a sighting

Data analysis and results

The degrees corresponding to each sighting are then used to compute the radial distance and sighting angle, which then provided the perpendicular distance of the sighted bird from the line-transect. As the line-transects were placed randomly and peafowl are more or less distributed uniformly in the campus, the frequencies of the perpendicular distances would have been approximately the same. However, as expected it was observed that as the perpendicular distance increases, its frequency decreases. This indicated that as the distance of a bird from a line-transect increases its probability of detection decreases. The frequencies of the perpendicular distances are then used to estimate the detection probability, that is, the probability of sighting a bird that is present within a perpendicular distance of say *w* meter on either side of a line-transect. This probability was then used to estimate the count of the birds

within the strips of width 2*w* covering the line-transects. Finally, the abundance estimate for the whole region was obtained through extrapolation. Table 1 shows the details of one of the surveys conducted in each of the years 2018 and 2019.

Table 1: Details of the surveys conducted in years 2018 and 2019

Survey Year	Aggregate length of line-transects in meter (*L*)	Strip width considered for analysis (2*w*)	Number of sighted birds within the strip (*n*)	Mean cluster size	Encounter rate (*n/L*)	Detection probability	Abundance estimate
2018	8237	140	128	2.62	0.015	0.66	499
2019	8329	140	113	3.38	0.013	0.84	450

*****