Flight of Fritillary: application of Citizen Science in ecology and conservation

E.Rothero, M.Dodd, M.Dyson, I.Tatarenko, D.Gowing

Open University, Milton Keynes, UK, email: floodplain-meadows-project@open.ac.uk

Fritillaria meleagris L. (Liliaceae) is a critically endangered species (European Red Data List) growing in the UK in old meadows, which have not been ploughed or improved for several hundred years. In total, 27 known populations are considered to be wild across the UK. The largest population of the species containing approximately 80% of UK snakeshead fritillaries is located on North Meadow - an ancient floodplain hay meadow lying in the upper river Thames valley near the Saxon town of Cricklade (Wiltshire). As bumble bees are considered being major pollinators of *F. meleagris* (1), with substantial decline in bumble bees numbers recorded in the UK in recent years (2), there is a danger for success with seed production of *F. meleagris* and, as a result, a significant decline in its wild populations.

Since 1999, ecologists of the Open University have been running a survey program on fritillaries population dynamics with the help of volunteers participating in individual plants count and measurement. In 2012, the project has been expanded to two more protected sites Lugg Meadow and Clattinger Farm with volunteers being involved not only in plant counts for one day in April during the species mass-flowering, but also in bumble bees survey throughout the whole growing season from April to October. The project has got a name “The flight of Fritillary” and represent a medium-size Citizen science, scientist-led project with involvement of main UK conservation organisation, Natural England (for North Meadow), as well as Wiltshire Wildlife Trust (for Clattinger Farm) and Herefordshire Nature Trust (for Lugg Meadow) and British Bee Conservation Trust. 79 volunteers took part in surveys on three sites in 2012. The data collected are stored in the data base and analysed by professional ecologists of the Open University. The data on bumble bees count are added to the National Bumble bee data base and will be analysed by BBCT.

The methodology of rare plant count includes monitoring of permanent quadrats scattered across the meadows on pre-designed grid (Fig. 1). The Fritillary population survey is conducted in the second half of April when most individuals are in flower. One metre quadrats are divided into 10 square centimetres for count convenience, the location of the individual plant, flowering or vegetative status, height, number of leaves and flowers (if more than 1) as well as flower color are recorded on the record sheets provided. Before recording, volunteers are given detailed instructions and an explanation about counting and measurement along with basic plant identification skills allowing them to distinguish non-flowering individuals of *F. meleagris* from similar looking species like small sedges, seedlings of *Tragopogon* and *Plantago lanceolata* (Fig.2). Monitoring scheme covers 200 quadrats on the North Meadow, 100 on Lugg Meadow and 100 on Clattinger Farm.

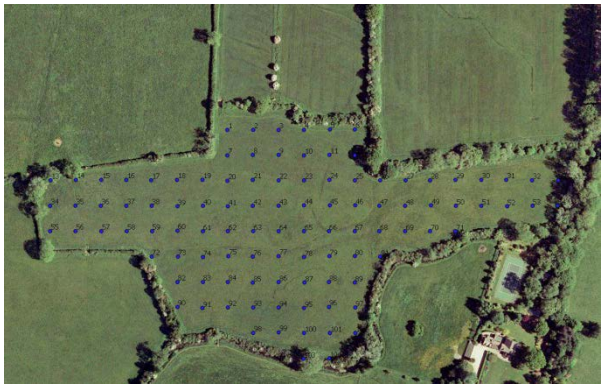

Fig. 1. Pre-designed grid of Fritillaries monitoring quadrats locations on Clattinger Farm.

Fig. 2. Volunteers counting Fritillaries on marked quadrats on the North Meadow, April 2012.

For bumble bees count, volunteers were given training in main species identification before carrying out the surveys along the transects, which covered not only the meadows with Fritillaries count locations but also the neighbouring fields and field margins as the most suitable places for bumble bees nests (Fig. 3 and 4).

Fig.3. Bumble bee transect on Clattinger Farm.

Fig.4. Red tailed bumble bee (*Bombus lapidarius*) – one of the main pollinators.

Comparing three Fritillaries populations surveyed in 2012, the differences in age-group compositions and total number of vegetative and flowering plants were noted between the sites (Fig. 5 and 6). Numbers of juveniles being similar on all three sites, indicate relatively even seed reproduction success despite of prominent differences in proportions of flowering plants in different populations. High relative number of flowering plants in Lugg population (Fig. 5) can reflect the high speed of vegetative propagation of that particular age group rather than its high impact into the seed reproduction. That's where the data on pollination success by bumble bees will be crucial for the data interpreting.

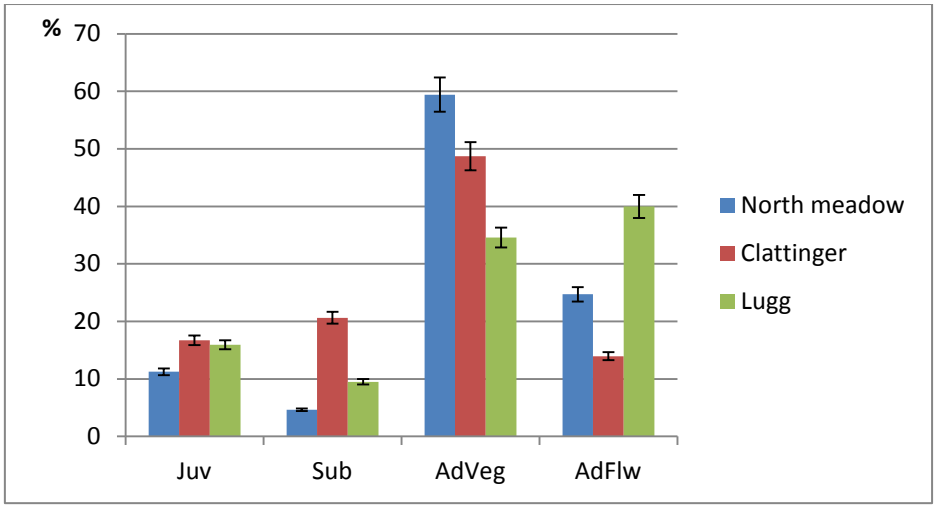

Fig. 5. Relative ratios of the age-groups in three populations of Fritillaria meleagris. (Juv – juvenile (1 leaf), sub-adult (2-3 leaves), adult vegetative (4 leaves and more), adult flowering (plants having flowers).

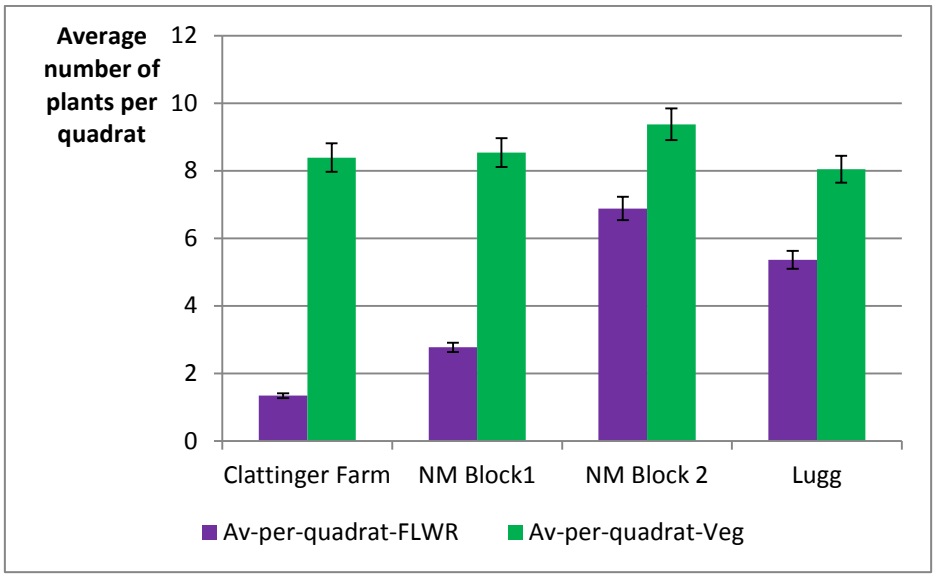

Fig.6. Average number of vegetative and flowering plants per quadrat on three sites. North Meadow monitoring quadrats were combined in two blocks, which differ in hydrological conditions.

An average density of vegetative plants per quadrat is similar in all sites studied with significant differences ($p<0.05$) in flowering plants numbers (Fig.6). For further analyses and interpretation of the results, more observations on pollination success are needed. ….

Eight species of bumblebees were recorded on the three sites during spring and summer 2012: Red tailed bumble bee (*Bombus lapidarius)*, Common carder bee *(B.pascuorum)*, Buff tailed bumblebee *(B.terrestris)*, White tailed bumblebee *(B. lucorum),* Garden bumblebee *(B. hortorum),* Early bumblebee *(B.pratorum),* Red shanked carder bee *(B. ruderarius),* Southern cuckoo bumblebee *(B. vestalis).* The numbers of queens, worker bees and males fluctuated according to the season in all three sites as it's predicted by bumble bee seasonal life cycle (Fig.7), which is a good indicator of bumble bees have been recorded correctly by volunteers.

Comparing the appearance of bumble bees on our three sites (Fig.7), the noticeably lower number of them was recorded on Clattinger Farm. For the explanations, additional investigation on suitable nesting areas on that site is required. Difference in ratio of worker bees and males on the Lugg Meadow can be explained by the dominance there of *B.pascuorum*, which seasonal life cycle differs from other species.

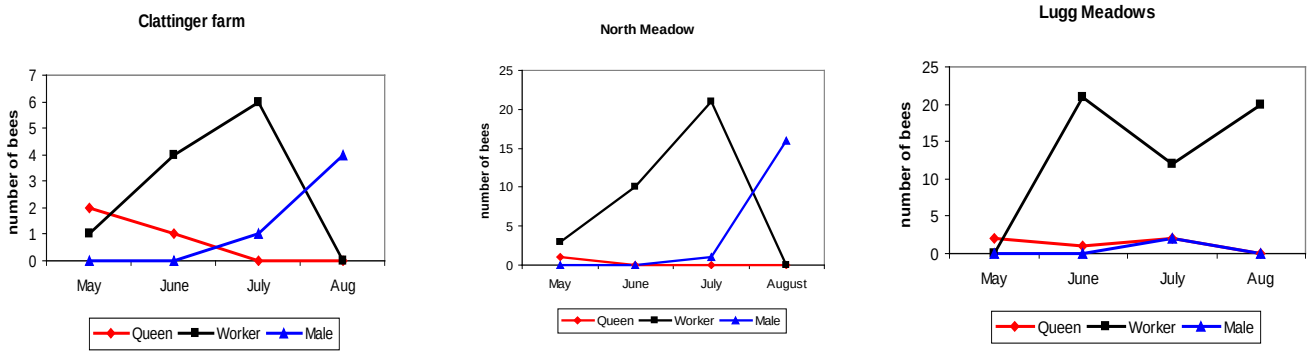

Fig.7. Seasonal dynamics in the number of queens, workers and males bees on three sites studied in 2012.

The question “How viable is data collection by voluntary groups”? – is one of the central arguments in citizen science. In order to assess this, 15% of quadrats were randomly re-counted by professional botanists in 2012 at the same time when main survey was done by volunteers. As expected, there were some disagreements between surveys especially with the quadrats having large numbers of vegetative individuals of Fritillaries, however the difference was not statistically significant (p-value>0.79). That strongly supports the validity of data collected by volunteers and confidence with using them for the data analyses.

This project highlight the importance of citizen science in ecological studies when the long-term or detailed monitoring data are to be collected for the investigation, which would not be carried on by professional ecologists because of large costs. The “Flight of Fritillary” has just started, however the results from the first year have already show some predictive values. Another important outcome is in updating the experimental design on the bases of preliminary analyses to obtain more data for the final analyses. With development of such citizen science projects as “”Flight of Fritillary”, more public engagement in experimental design and data analyses will be expected.

Literature cited

1. Zych, M, Stpiczyn´ ska, M . Neither protogynous nor obligatory out-crossed: pollination biology and breeding system of the European Red List Fritillaria meleagris L. (Liliaceae). - Plant Biology, 2011. - P. 1-10.