Flight of the Fritillary (Phase 2)

Emma Rothero

June 2018

Key staff: David Gowing, Irina Tatarenko, Mandy Dyson, Mike Dodd

Contact point: Emma Rothero 01908 655645

Executive Summary

The Floodplain Meadows Partnership (FMP), hosted by the Open University, has been collecting data on the rare plant species snake's-head fritillary at a National Nature Reserve (North Meadow, Cricklade, Wilts) since 1999, using volunteers. The main pollinator of the snake's-head fritillary is the bumblebee and the FMP became concerned that reported declines in bumblebee populations would have an impact on this plant. In 2012, funds were secured to expand the numbers of volunteers counting across two new sites and establish bumblebee surveys on the three sites. In 2015, further funds were secured to continue and develop the project.

Over six years the project increased the numbers of volunteers more than three-fold through wide advertising. Annual workshops were run to enable volunteers to engage in the findings and the research process. Volunteer attendance at counts and workshops was maintained and volunteer engagement assessed through questionnaires and interviews. Evidence arising from the project has led to new ecological information about a rare plant found on internationally important sites for nature conservation and more in-depth volunteer research is showing a link between the snake's-head fritillary and bumblebees.

Data collected by the project are used in 3 Open University undergraduate courses and the project has maintained a wide external profile, engaging with many organisations outside the University and with slots on Countryfile, BBC Farming Today and BBC Wiltshire.

Aims and scope of your project

- What were the main aims of the project?

North Meadow is owned and managed by Natural England, and is home to 80% of the UK's remaining populations of snake's-head fritillary (*Fritillaria meleagris*)Each April, Natural England manage many thousands of visitors who come and see the fritillaries in flower.

The FMP data collection has been done using volunteers through an annual fritillary counting day. The information collected has been entered into a database and trends of change noted. Management recommendations are fed back to the site manager to try to ensure that the site maintains its wildlife value, and over the years the numbers of plants has been steadily increasing.

Recent Dutch research showed that their fritillaries are pollinated by bumblebees. We wished to observe bumblebee behaviour on several key sites to see whether they follow this pattern, and also set up a mechanism to survey the bees themselves. These pollinators may be essential for the survival of fritillaries, and it is widely reported that they are declining in the wider countryside. Could this be an increasing problem for the survival of the UK populations of snakeshead fritillary? What benefit may the early flowering fritillary have for bumblebee populations and thus for an important ecosystem service: crop pollination.

We had no knowledge about whether the trend for increasing fritillaries at North Meadow is due to management changes, the wider climate or other factors or in fact whether fritillaries are in fact decreasing elsewhere.

We wished to develop all this work in Phase 2 of this project through an expansion of the volunteer population, and to determine whether we could engage volunteers over a longer time frame, assessing their level of interest and engagement in the project. We also wished to trial engagement techniques with children from Key Stage 3 schools local to the count sites.

Data generated by the project is already used in undergraduate courses and supports three current PhD students. The scientific fundings coming from the project are leading the way to a specific PhD student studying the dormancy elements of snake's-head fritillary, and we have already started collecting seed in order to create a study meadow to this end.

- What were the more specific goals

We wished to:

1. Run three fritillary count days and associated bee surveys
2. Undertake data analysis and interpretation.
3. Undertake further research (including engagement of Key Stage 3 students in the collection of field data and data analysis)

Activities

- What was the overall approach (e.g. observe current practice, develop technology, plan and evaluate change, etc)

To undertake plant and bee surveys using volunteers and to understand how to engage with volunteers more effectively, ensuring they keep returning to undertake volunteer activities and that they gain benefit from this experience. Also, to trial a method to engae with KS3 children in better scientific data collection and analysis skills through working with a local college to establish a regular survey programme for science students.

- What were the planned activities of the project?

1. Data analysis and interpretation

Activities:

a). Enter all 2015/16/17 fritillary data and establish student data analysis project.

1. Data collected during snakeshead fritillary counts from 1999 to 2010 have been used in S396 (Ecosystems) module for an Empirical modelling activity which will enable students to develop their own model of response in a plant population to changes in soil hydrology. The data collected during 2011-2016 are being used for activity on the model verification in S397. Required data sets of plant numbers and hydrology of the meadow have been entered into the database and have been passed to the module team for the new presentation

   Data from North Meadow illustrate the species resilience mechanism to dramatic environmental change. After the extreme flood of 2012 (10 months), almost the entire population of snakeshead fritillaries became dormant in 2013. In 2015, the population experienced another stress from a prolong spring waterlogging on the site. These data give an additional opportunity to assess the species response to the extreme environmental situation depending on different hydrological micro niches on the site. These data can be used to illustrate the species likely adaptations to climate change.

   Fritillary and plant diversity data are now incorporated into S396 and S206, and we are still working on a mechanism for intergrating this into SDT306. The module team for "Environment:

responding to change" wish to use the data to illustrate the concept of how species have adapted their biology to survive unpredictable weather events.

2. Additionally, a poster was presented at the conference of the British Ecological Society in 2017 (Tatarenko et al. 2017), and a paper is due to be published this year.

Ecological information collected

- Each year we collected 400 1 x 1 m ^{2} quadats worth of data on snakeshead fritillaries.
- We walked monthly bumblebee transects at 3 sites
- We undertook a pilot research study with a small number of volunteers to determine pollination success of fritillaries over 3 years.

Ecological findings are:

- Fritillaries have a strong preference for well drained sites
- Dormancy is a regular feature of the population ecology, triggered by saturated soil and/or low soil temperatures during the growing season
- Consistent dominance of vegetative plants over flowering can be partly explained by occasional increase in seedling numbers exploiting a particular 'onthogenetic niche' (Cameron, 2014).

3. Run three fritillary count days and associated bumblebee surveys.

The volunteer count days and bumblebee surveys were all run in 2015, 2016 and 2017. The original project started in 2012, seen in the graph in Figure 1 through the increase in volunteer numbers at that point. The winter workshops and counts were then sustained at a higher level. Each site count was run with a different type of public engagement.

Volunteer engagement information collected

Year 1 - 2015 Counts, bee surveys, bee research programme
Names and number of volunteers attending activities

Year 2 - 2016 Counts, bee surveys, bee research programme
Names and number of volunteers attending activities

Year 3 - 2017 Counts, bee surveys, bee research programme
Names and number of volunteers attending activities
Feedback questionnaires from volunteers

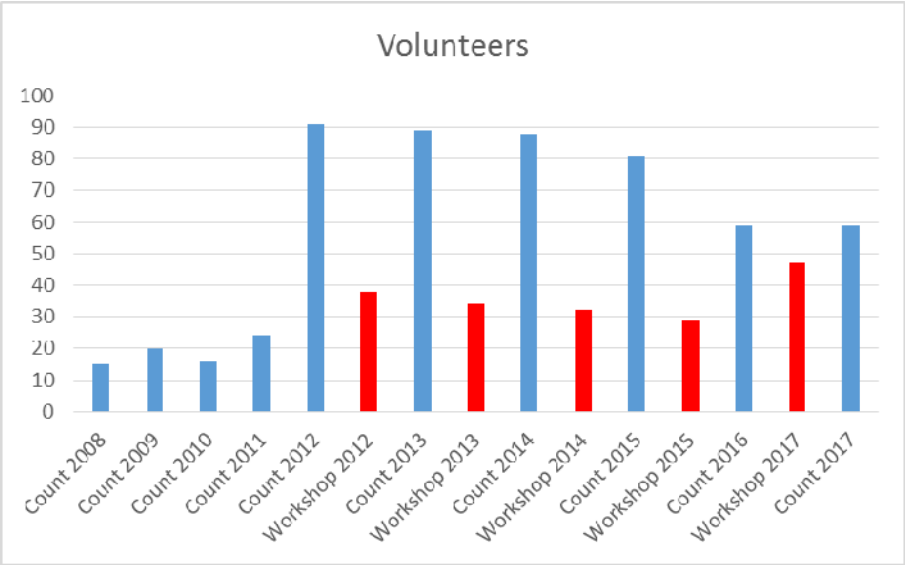

Figure 1. Number of volunteers returning to the count and to attend the workshop 2008-2017

However when looking at the number of volunteers returning for each site, there does not appear to be a great difference, suggesting that the different levels of engagement were not a significant influencing factor in whether volunteers maintained an interest or not.

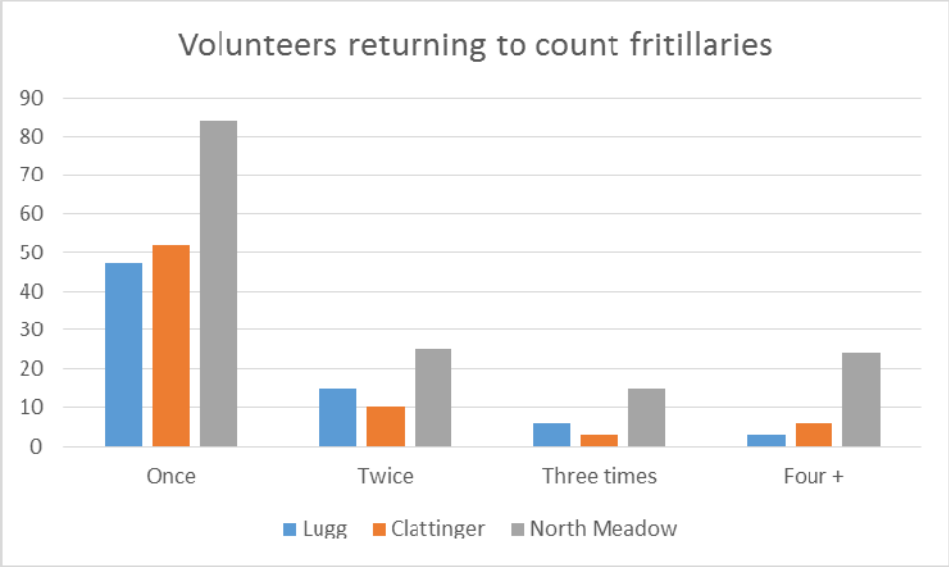

Figure 2. Number of times volunteers have counted at the three sites and total numbers counting at each site.

Table 1. Different methods of volunteer engagement used at each site:

	National media	Local media	Guided walk	Family event	Presence at site entrance
Clattinger		√			
Lugg		√	√	√	√
North	√	√			√

Meadow					

Winter workshops

Winter workshops have been continued for the life of this project as it has proved an excellent way to engage with volunteers and maintain their interest. In 2017 it was particularly well attended, with over 50 volunteers and standing room only.

We now have 5 years of data on bumblebee counts (collected by volunteers) at 3 meadows and this, together with the fritillary count data (also collected by volunteers) will be analysed to determine the extent to which fritillary flowering time (which is weather dependent to some extent) affects bumblebee numbers. Our pollination work suggest strongly that queen bumblebees are alsmost entirely dependent of fritillaries for food and for nest establishment and that any delay in flowering (or lack of flowering due to flooding) may adversely affect bumblebee numbers.

The questionnaire responses from 2017 show the reasons the volunteers choose to come, and what they feel they have learned from their experiences. These are summarised in Figures 3 and 4 below and suggest that peole prediominantly come because they want to help nature, and are mainly learning plant identification skills.

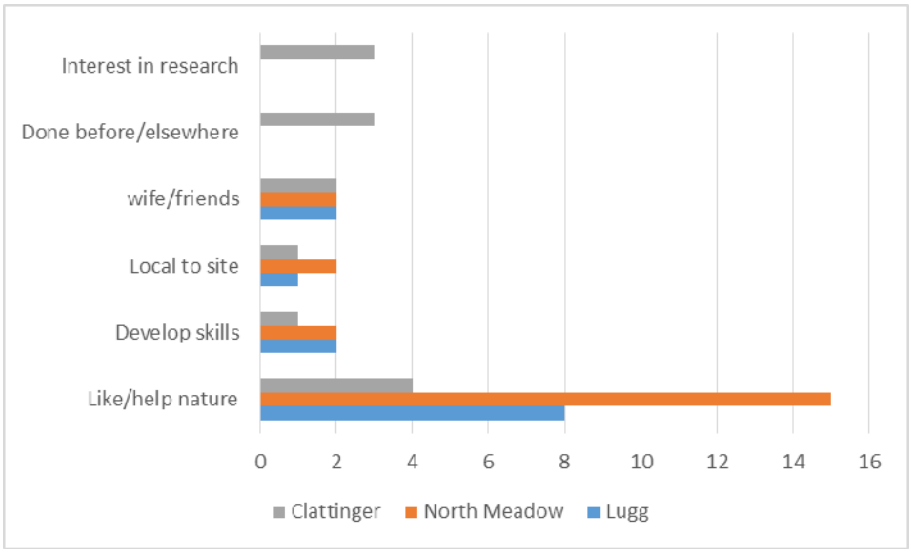

Figure 3. Summary of volunteer responses to the question 'What motivates you to come along?'

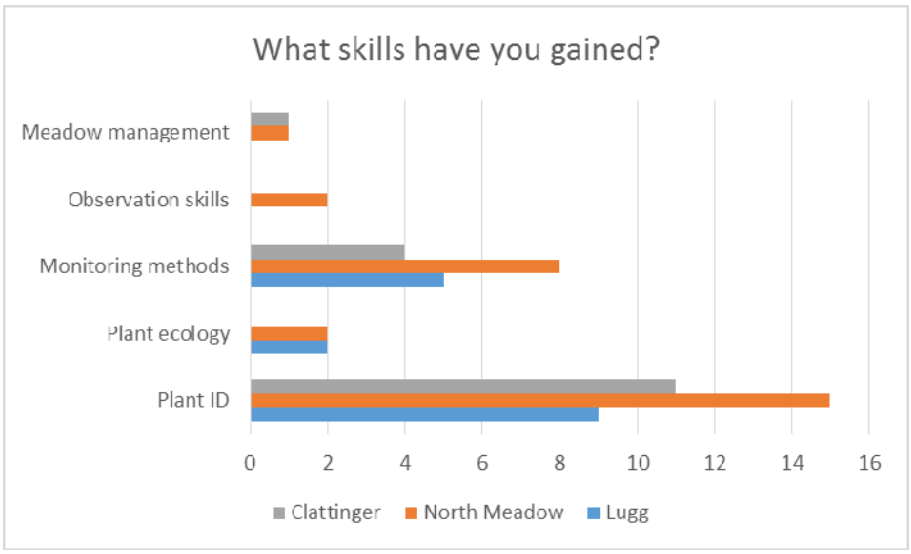

Figure 4. Summary of volunteer responses to the question 'What skills have you gained from attending fritillary counts, bumblebee surveys and winter workshops?'

2. Further research.

Activities:

a). Make contact with experts to assess the technological requirements for a motion sensitive, high quality camera that can be used in the field.

b). Consider options for accessing equipment and determine appropriate field location for camera including securing permission for field site.

c). Trial method in April 2014 to determine if findings from camera can be used to undertake a more detailed assessment of plant-pollinator interactions using staff and equipment from Kew who have developed this technology. Tasks include setting up camera at field site, establishing local volunteers to check equipment and OU staff (Mandy Dyson) to assess methodology, understand how the technology works and determine whether this is a viable research and teaching method. Promote to students and volunteers in March 2014 and April 2015 and 2016

A camera was purchased and allocated to a key volunteer and OU student to undertake a study of pollinator behaviour. We were unable to develop the relationship further with Kew however due to their lack of resource and staff time.

Additionally, a small study was initiated in April 2016 to investigate the relationship between bumblebees and snakeshead fritillaries at North Meadow. A sample of 50 random plants that were in bud were bagged to prevent bumblebees from accessing them. Another random sample of 50 plants were left unbagged and so were accessible to pollination by bumblebees. The aim was to determine how important bumblebees are in pollinating the flowers. At the end of flowering, both unbagged and bagged plants were examined for the presence of seed pods (indicating pollination had occurred). Seed pods were collected from those flowers that produced them. The absence of seed pods on 100% of bagged flowers suggests that without bumblebees, pollination of fritillaries occurs rarely. None of the bagged flowers produced seeds while around 70% of the unbagged flowers did. Further analysis, including seed counts are currently being undertaken

In addition, 20 flowers were monitored from closed bud stage to seed production to gain a better understanding of the breeding system of these plants. Flowering duration, nectar production and pollen presentation data were collected over the period of study. This study will be repeated next year to determine any significant differences in flowering time and nectar and pollen production between years.

Video footage, using two cameras, was taken of pollinator visits to flowers over a period of 2 weeks. This footage is yet to be analysed (awaiting delivery of a suitable desktop computer capable of playing the videos) but observations suggest that bumblebees were by far the most common pollinator visiting the flowers, with honeybees and solitary bees seen on rare occasions. The most common bumblebee seen on flowers was the red tailed bumblebee B*. lepidaris*.There are few studies looking at the relationship between bumblebees and fritillaries so our results, once analysed, will contribute significantly to the understanding of the interaction between them and the conservation of both bumblebees and fritillaries.

This data, together with the data collected in 2017 will be written up with a view to publish it in a scientific journal.

In 2017 we started to study the pollination story in more detail. This has started to yield some interesting findings This research is also drawing upon a small number of local volunteers to help with recording bumblebee sounds and with bumblebee counting.

We have collected data on the number of bumblebee visits to fritillaries during a foraging bout, the duration of the visits and the number of flowers that are inspected but rejected per bout. Preliminary analysis suggests that:

-Queens visit more flowers than workers and engage in longer foraging bouts

-Workers spend more time inside flowers than queens do

-A similar percentage of flowers are rejected by queens and workers (about 40%)

We have also collected a total of 14 pollen samples from bumblebees for analysis. From this we hope to establish the predominant flower species that the bumblebees are using as a source of pollen.

We have also marked 30 flowers and have monitored their progression from the bud stage to the production of a pod, noting the length of time they present pollen and nectar. The pods have been collected and the seeds counted to determine the extent of of successful pollination. We also marked 50 early flowering plants (bud stage in March) and 50 later flowering plants (at bud stage in April) to see if there is any difference in pollination success. Early flowering plants are almost entirely dependent on early queens for pollination while those that flower later are exposed to a greater variety of pollinators and also to worker bumblebees.

Finally, we have begun recording bumblebees to determine the extent to which acoustic signals differ between species and between queens, workers and males.

3. Engagement of KS3 students.

Activities

a). Establish links with local schools in Hereford to generate interest in real field data collection through the Herefordshire Nature Trust 'Wildplay' project.

b). Develop group interested in taking part in fritillary counts and establish possibility of school based experiments using fritillaries in pots. Promote remote camera if functional as a possible media based experiment.

c). Explore potential for a crest award using regional Crest contacts.

d). Consider success of Hereford schools project after first year and start to investigate other schools who could be engaged (Milton Keynes, Wiltshire).

The Wildplay team were appointed to work with the local secondary school in Hereford and took the after school science club out to the Lugg Meadow to look at meadow ecology and survey methods. In the second year, the format of the work changed however, as the school decided they did not wish to continue with this idea. Instead of the afterschool science club visiting the site again, the Trust worked with the school to set up regular monthly bee surveys by establishing a youth survey group. This carried on for one season. In the final year of the project however, the school pulled out altogether. The Wildplay team instead worked with the Hereford Sixth Form College to develop a group who can undertake the Beewalk surveys, as well as run the usual fritillary festival outreach activities.

The school were not interested in an on site experiment, nor in developing a link to the Crest Award. The poor results from this element of the project suggest that significant input is required to develop links with schools, and that in this case, we did not find a method that worked sufficiently well to replicate elsewhere.

What changes did you have to make to your plan (aims, project activities, etc.) and why (e.g technical problems, difficulties in involving users/stakeholders, etc)?

School engagement – proved difficult. We trialled different methods as the initial proposal did not work well, however we would not develop this further in future.

Lack of development of the relationship with Kew meant we changed the camera project as described.

<u>Impact</u>

a) Student experience

- In what ways has your project impacted on student learning?

Feedback from Tutors is that students really like the fritillary-hydrology model used in S396 (Ecosystems) module and the tutors are pleased that it is still in the new version of S397. The activity introduces them to ecological modelling by providing a easily understandable system thereby laying a foundation to understanding more complex models later in the module.

Updated data are also fed back into course work and the project offers student opportunites to come and experience botanical survey work in the field.

- How is your project contributing to increasing student success (i.e. retention, employability, etc.)?

Ecological modelling is a key skill required by environmental scientists. The activity using Floodplain meadows data is an excellent (and currently in use) example of how natural environments can be managed in a sustainable way.

- Have there been or will there be any benefits to students not directly involved in your project?

Our data is used in a number of courses including in S397 and S396 (Ecosystems) module for an empirical modelling activity.

Fritillary and plant diversity data are now incorporated into S206, and we are still working on a mechanism for intergrating this into SDT306. The module team for "Environment: responding to change" wish to use the data to illustrate the concept of how species have adapted their biology to survive unpredictable weather events.

b) Teaching

- How have you affected the practice of both yourself and others within the OU?

- What has been the impact of your project outside the OU?

We have continued to have a good amount of impact externally as our project was largely focussed on engaging partners and volunteers external to the academic environment. We continued to engaged with Herefordshire Wildlife Trust, Wiltshire Wildlife Trust, Plantlife, Natural England, Bumblebee Conservation Trust, the Environment Agency and Botanical Society for the British isles, and a raft of individual volunteers in developing and delivering this project. As a result we have become known as a centre for expertise on the ecology of snakeshead fritillary and a hub for information exchange about this species. There is a signficiant amount of interest about this species amongst the wider public due to the unusual and beautiful flowers, its rarity and its visual appearance en masse in April at a time when there is little colour in the wider countryside. The scientific data collected are used in making decisions about management of internationally important sites for nature conservation.

We have had articles in national broadsheets and local papers. We were selected by the British Ecological Socity to present a poster at their 2017 conference. We have also talked about the project at other conferences and in presentations.

We were invited to contribute towards a slot on Countryfile about the volunteer counts. They also used some of our footage of bumblebees pollinating fritillaries.

The Floodplain Meadows Partnership published our Technical Handbook in 2016 which is now on its third re-print, and used data generated from this study in a specific case study. Copies have been supplied to all major offices of all UK Nature Conversation organisations.

We were interviewed by Radio Oxfordshire and for a magazine article in 2017 for Countrywide magazine.

As part of an interview for BBC Wiltshire, there was some feedback on the volunteers from the interviewer, as follows:

'I was really impressed with your volunteers. They were so knowledgeable and passionate and willing to share their experience. My favourite comment came from a volunteer who manages a team at the Environment Agency (Alison Futter I think). She said being in a meadow of wild flowers, counting them made her happy! Patrycja Meadows (great name!) who was working with her was great too, she said she loved the feel of the plants, she finds if a real privilege and has only missed one year in about 8, and that's because she was having a baby. Richard Aisbitt from Swindon gave me some lovely quotes too, as did Kathy Sterne from Melksham. They were all quite inspiring!'
Rebecca Holder, BBC Wiltshire

Rebecca also gave us the recordings of the interviews, which we will put onto the website, over the summer (we can't update the website yet as it is undergoing some development).

The piece that she did for BBC Radio Wiltshire was used in full on BBC Radio 4's Farming Today, and had a second, longer air on BBC Radio Wiltshire's 'Wild About Wiltshire' programme.

Short films have also been made about the project and promoted on YouTube:

Emma Rothero talking about snake's-head fritillary, volunteer counts and dormancy.
'Snakeshead fritillary defies climate change'
https://www.youtube.com/watch?v=G6JfQwonm78&feature=youtu.be&list=PL9tlzHAsB0s8yLfg7fhh7ZAEylynOCNrv

David Gowing talking about research impact, using snake;s-head fritillary counts as a background topic. 'Protecting plants in floodplain meadows'
https://www.youtube.com/watch?v=H01mrGwJw6I&list=PL9tlzHAsB0s8yLfg7fhh7ZAEylynOCNrv&index=1

Schloarship short with Emma Rothero, Estmme video from Phase 1:

http://www.open.ac.uk/about/teaching-and-learning/esteem/projects/themes/engagement/flight-the-fritillary

Internationally, the project was presented at conferences including:

- BES Annual Meeting, 2017, Gent, Belgium
- International Workshop on Research and Conservation of Floodplain Meadows. 2013. Kaluga, Russia

c) Strategic change and learning design

- What impact has your work had on your Unit's or the University's policies and practices.

This project will be listed in the REF21 submission as part of an Impact Case Study around engaging the wider public in research.

List of deliverables

Please provide a list of any deliverables that will be of value beyond the life of the project such as websites or Wikis (URL), publications (pdf), papers (pdf), etc. Please reference papers and publications in full. Relevant files should be sent separately for inclusion on the eSTEeM website.

Website; specific web page dedicated to this project:

http://www.floodplainmeadows.org.uk/about-meadows/wildlife/snakeshead-fritillaries

An updated fritillary leaflet, used to provide general ecological information about the snakeshead fritillary and the project, distributed as part of guided walks and meadow open days to the general public. Also available on the website:
http://www.floodplainmeadows.org.uk/sites/www.floodplainmeadows.org.uk/files/Final%20Frit%20Leaflet%20Feb%202017.pdf

Floodplain Meadows Partnership Technical Handbook. The externally-funded publication has been distributed widely amongst the professional conservation community and local groups with an interest in floodplain meadows more widely. It is available to buy in hardback, or as a free download:
http://www.floodplainmeadows.org.uk/floodplain-meadow-technical-handbook

Figures and tables

List of figures and tables provided in the report.

Figure 1. Number of volunteers returning to the count and to attend the workshop 2008-2017
Figure 2. Number of times volunteers have counted at the three sites and total numbers counting at each site.
Figure 3. of volunteer responses to the question 'What motivates you to come along?'
Figure 4. Summary of volunteer responses to the question 'What skills have you gained from attending fritillary counts, bumblebee surveys and winter workshops?'
Table 1. Different methods of volunteer engagement used at each site

References

Tatarenko, I., Dodd, M., Rothero, E., Gowing, D. 2013. Citizen science in meadow studies: population dynamics in Fritillariameleagrison North Meadow (Wiltshire, UK). In: Research and Conservation of Floodplain Meadows. Kaluga, Russia.

Cameron, F. 2014. Ontogenetic niche shifts within floodplain meadow species. Thesis for MPhil, Faculty of Science, Open University. 165 p.

Tatarenko, I., Dodd, M., Rothero, E., Gowing, D. 2017. Effect ofprolonged dormancy on the population dynamics of Fritillaria meleagris. Poster at the BES Annual Meeting, Gent, 2017.

Volunteers counting fritillaries at North Meadow, Wiltshire (Mike Dodd)

Volunteers counting fritillaries at Clattinger Farm, Wiltshire (Mike Dodd)

Volunteers counting fritillaries at Lugg Meadows, Herefordshire (Mike Dodd)