

To everything there is a season

climate impacts on frog breeding times

Data from ECN sites show that frogs are responding to milder springs by breeding earlier

Frogs and toads are sensitive to environmental change and their populations have suffered widespread declines, even extinctions, in recent decades. Climate change is one possible cause of this, and the predicted drier summers and lower soil moisture in the UK are expected to further impact amphibian populations. Warm dry weather may reduce the surface area, depth and number of ponds in which amphibians breed, whilst increased exposure of embryos to the sun's ultraviolet radiation - as a result of lower water levels - increases vulnerability to parasites.

One effect of climate change, seen in many plant and animal species, is a change to the timing of lifecycle events. These *phenological* changes are important because they can result in the decoupling of dependent processes

within ecosystems. Hence the birth of young may be synchronised with an abundance of food, for example; but if hatching is brought forward by warmer weather in spring, food may be in short supply, and this may in turn affect the survival of young.

ECN monitoring of the common frog, *Rana temporaria*, the UK's most common amphibian, has revealed phenological impacts of climate change. Measurements include the date when breeding congregation begins, the date of first spawning, spawn quantity, evidence of spawn disease, the progress of embryo development and the date when froglets leave the pond. Eight ECN terrestrial sites have frog ponds suitable for monitoring, and there are records from 1994 for most of these sites.

The time at which frog breeding starts in the UK varies greatly; in some years it may begin during December in Cornwall compared with April at high altitudes in the

Pennines and in Scotland. In a particular pond, however, annual variation in spawn date tends to be relatively low. This can be seen in the ECN data, as shown in the figures opposite.

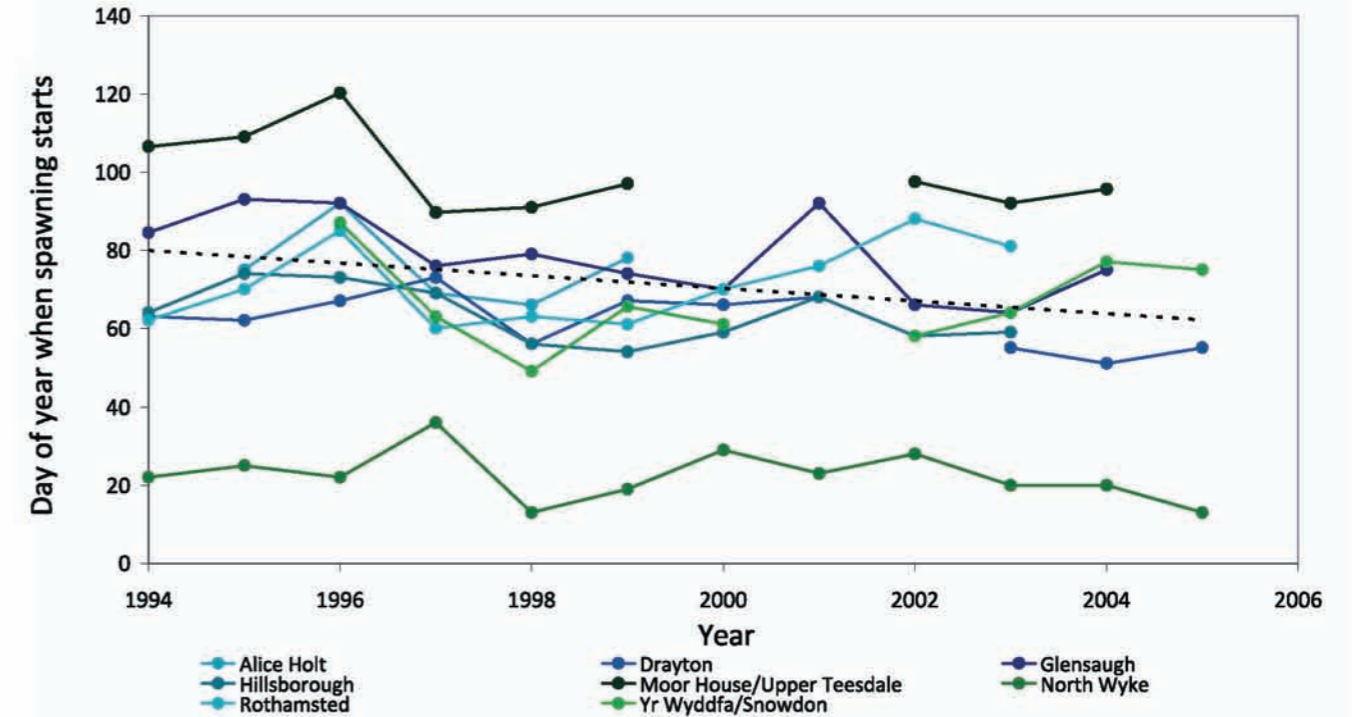
Analysis of ECN data shows that, throughout the UK, key events in the common frog's reproductive cycle are occurring earlier and over an extended duration, as shown in the table. A variety of weather variables were investigated as the possible cause of these trends. The results are similar for congregation, spawning and hatching; there are strong negative correlations with air and soil temperatures and weak positive correlations with

Lifecycle event	Number of days...		
	... by which the event start has advanced between 1992 and 2006	... by which the interval between events has lengthened	... of advancement per °C rise in temperature
Congregation	17.3		9.4
Spawning	9.6	↓7.7	5.4
Hatching	7.0	↓10.4	4.5

Summary of the changes in timing of key frog lifecycle events. From data recorded at ECN sites with frog ponds over the period 1992-2006

surface wetness. The observed temporal trends over the last 12 years are apparently due to rising mean temperatures at ECN sites.

The ECN results, when taken in conjunction with previous studies¹, suggest that the reproductive cycles of all monitored British amphibian species are becoming earlier in response to rising temperatures, and that this has been happening since at least the late 1970s. Such a widespread and long-term phenomenon indicates that the impacts of climate change are well underway in the UK.



▲ Trend in date when frog spawning begins at ECN sites. The black line shows the linear trend for all the sites. Eight terrestrial ECN sites have ponds where frogs are found.

► Differences in frog breeding cycle dates between ECN sites. Mean annual dates. Sites are shown in latitudinal order, from the most northerly (Glensough) to the most southerly (North Wyke). Not only do lifecycle events take place at different times, the duration of events also differs across the network. (At Drayton, congregation has not been recorded).

