



Online Ethics Center
FOR ENGINEERING AND SCIENCE

Selected Issues in Depth - Genomics and Wildlife

Description

Part of unit 5 of the [Course on Genomics, Ethics and Society](#), this section provides video clips from Dr. Gould from North Carolina University discussing how genomics can be used in biological pest control and connected ethical issues.

Body

The selected issues in depth portion of Genomics and Wildlife takes a look at how genomics can be used in biological pest control. Disease vectors are found worldwide, and are responsible for human suffering and economic loss in terms of agriculture and livestock. Dr. Gould, the William Neal Reynolds Professor of Agriculture at North Carolina State University (<http://www.cals.ncsu.edu/entomology/Gould>), discusses a series of cases where genomics may be used to control disease vectors, producing genetically modified organisms to do so. As we've seen, producing GMOs is almost always controversial. The first clip addresses one aspect of the controversy here: the idea of *trust* in the context of genetically modified organisms (GMOs). The basic question is: do you trust the agency producing the GMOs? What are the agency's motivations for producing GMOs?

In this second clip, Dr. Gould introduces a species of transgenic mosquitoes (*Aedes aegypti*). These mosquitoes are genetically engineered to fluoresce green by inserting a piece of DNA from a jelly fish, known as green fluorescent protein (GFP). This is a common first order genetic engineering procedure to test the

transformation capabilities of an organism of interest. Dr. Gould uses this example to illustrate how genetically engineered mosquitoes might be used to combat malaria or dengue fever.

Having explained how mosquitoes can be genetically engineered to combat dangerous disease transmission, Dr. Gould briefly addresses some concerns about operationalizing malaria eradication in *Anopheles* mosquitoes. A further concern is the potential to eradicate *Anopheles* species that are not carriers of malaria, in addition to the 12 or so species that do carry the disease; it would be undesirable to eliminate non-target species. The important thing, Dr. Gould maintains, is to consider carefully how any biological controls will impact trophic cascades and biodiversity throughout the ecosystem.

The first three clips discussed the feasibility of genetically modifying mosquitoes to combat human diseases. In this next clip, Dr. Gould highlights one company, OXITECH, which is actually developing transgenic mosquitoes capable of combating malaria and dengue fever. This technology uses a similar business model to GMO crops, where the technology is leased to interested consumers to combat mosquito-vectored diseases.

OXITECH's process for mosquito eradication is to genetically modify mosquitoes so that their offspring will not survive (see week two readings for details of the process). They release male mosquitoes into the population that then mate with the wild population. Once the mated females lay their eggs, the GM larva outcompetes viable larva for space in pools of water. As the larva mature to pupation they die. This method can drastically reduce the population numbers of wild, malaria-carrying mosquitoes.

In addition to being a disease vector, mosquitoes are also considered nuisances in many parts of the world. *Aedes albopictus* is one such species of mosquito. Dr. Gould considers public perception of mosquitoes and the potential application of genetic modification and biological control to combat nuisance species (independently of any disease risk they may carry). Do you think that biological control of nuisance species should be carried out? What are the ethical and regulatory issues important to this application of genetic modification?

Informed consent is an important consideration in the implementation of biological control and in the field of genetics more broadly (see unit 7). It is easy to ask stakeholders about their willingness to participate in insect disease vector eradication programs when the tools used in the eradication can be implemented on a personal level. However, when biological controls are ubiquitous, such as the hypothetical application of small interfering RNAs (siRNA) to silence parasitism in nematodes through areal application, informed consent becomes a much more complicated topic. Dr. Gould addresses this topic within the context of GM mosquitoes. The concept of hazard (risk + exposure) and how individuals perceive risk is an important component of regulation. Community involvement and education are important components of developing genetic controls on biological pests.

As noted earlier, the issue of trust and motivation is an important one to consider in the field of biological pest control. Gaining stakeholder trust through community involvement, transparency, and education is a good first step. Dr. Gould asks the question “do you trust your government?” This seems to imply that motivation for undertaking genetic modification is an important component of the acceptability of biological control. Is it for profit? Is it for altruistic reasons?

In this clip, Dr Gould suggests that everyone has a motivation for undertaking genomic pest control. He also suggests that profit is not the only motive that can lead to unethical actions with regards to genetically modifying and deploying organisms.

Humans are not the only organisms affected by insect vectored diseases. Cattle and agricultural livestock are economically important in the US, and the loss of cattle by screwworm fly infection was at one time costly (1.6 billion dollars a year). Because of the large economic loss, the Screwworm fly was eradicated from North America in the early 1960s. Irradiated Screwworm flies were released to mate with wild populations, leading to non-viable screwworm flies and the eventual population crash of the species.

The method of Screwworm fly eradication mentioned in the last clip relied on chromosome breakage by irradiation of males; the release of the sterile males leads

to a population crash when offspring are non-viable. While screwworms have been virtually eliminated from North America, they persist elsewhere, so eradication is still needed. However, one problem is that it is impossible to differentiate males and females, which makes the irradiation technique difficult. Researchers at North Carolina State University genetically engineered Screwworm flies to change color based on the sex of the individual. In this fashion males can be identified for release in the eradication program.

Removing a species from ecological communities, however, has the potential to alter community structure in unintended ways. Additionally, development of genomic technologies for biological control may be developed for other uses, including terrorism. How can this technology and its uses be protected and used safely?

The last clip uses a species of Tsetse fly to highlight the importance of considering the ecosystem function of species before implementation of eradication.

Conservation genomics is, largely, concerned with preservation of genomic biodiversity. In this clip Dr. Gould discusses how eradication of some species results in "trophic cascades", a concept in ecology that describes how removal or addition of a species can result in cascading changes within the ecosystem. Moreover, Dr. Gould suggests that removal of biological pests could result in increased human presence with negative consequences for biodiversity and ecosystem health as a result.

The clips above provided a snapshot into the world of conservation genomics, focused primarily on utilizing genomics for biological pest management to combat infectious diseases. As Dr. Gould illustrated, there are many ecological complexities that must be considered when using genomics to modify wildlife (and plants too for that matter). Changing ecosystem biodiversity at the genomic level can have both positive and negative outcomes and it is important to involve all stakeholders and think broadly about how modification will alter the ecosystem and its function and service to humans.

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