

Sterile Insect Technique (SIT)

Birth control for insects

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Introduction

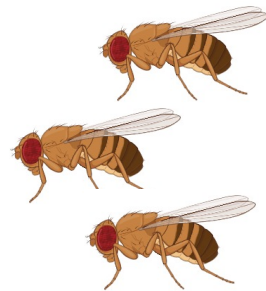
- ▶ Pest control challenges
 - ▶ Pesticide-resistant pests
 - ▶ spread of invasive species due to globalization
 - ▶ climate change
- ▶ Importance of pest control in
 - ▶ Agriculture
 - ▶ Public health
 - ▶ Conservation
- ▶ Sterile insect technique



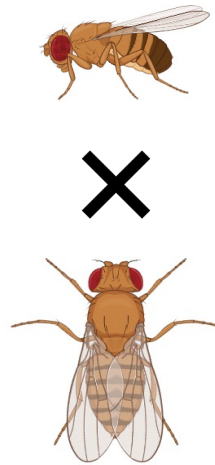
Concept



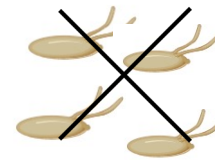
Make Sterile Males



Release among
wild population



They mate with
wild females

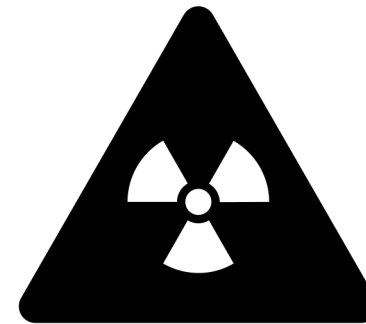


Females do not
lay viable eggs



Sterilization using Radiation

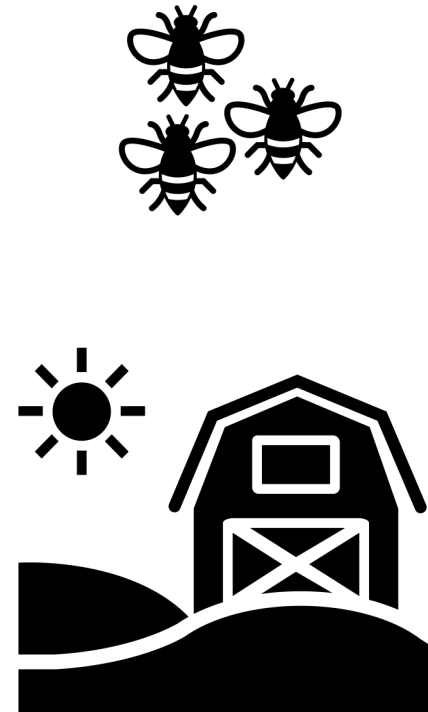
- ▶ Balancing Sterility and Competitiveness
 - ▶ release insects - both sterile and competitive with wild counterparts
- ▶ Dose Variability
 - ▶ carefully controlled - sterility and competitiveness
 - ▶ excessive doses - compromise competitiveness
 - ▶ insufficient doses - ineffective sterilization
- ▶ Dose Uniformity Ratio (DUR)
 - ▶ maintain consistent dose
 - ▶ how evenly the dose is distributed within the chamber



(Simuta *et al.*, 2021)

Mass Rearing facilities

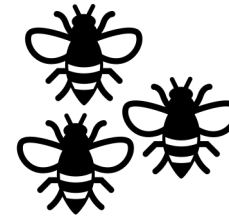
- ▶ Importance of Mass Rearing Facilities in SIT Programs
 - ▶ supply large numbers of sterile insects
 - ▶ help control pest population
- ▶ Components of Mass Rearing Facilities
 - ▶ insectaries equipped with breeding chambers
- ▶ Challenges in Maintaining Healthy Insect Populations
 - ▶ maintaining optimal environmental conditions
 - ▶ prevent disease outbreaks
- ▶ Best Practices for Healthy Insect Populations
 - ▶ strict hygiene protocol
 - ▶ monitor environmental parameters - temperature, humidity



(Tussey *et al.*, 2023)

Release Strategies

- ▶ Importance of Strategic Release Planning in SIT
 - ▶ effectiveness of insect releases - suppress or eradicate
- ▶ Examples of Successful Release Strategies
 - ▶ fruit flies - deploying sterile insects at the onset of the pest's reproductive season
 - ▶ mosquitoes - targeted release near breeding sites during periods of peak population density



(Alphey *et al.*, 2010)

Quality Control, Monitoring and Evaluation



Assessment Methods for Sterile Insects

monitor sterility levels through irradiation dose verification
assess physical fitness
reproductive capacity



Monitoring Techniques for Released Insects

survival, dispersal and mating success
DNA barcoding to identify released individuals



Monitoring Methods for Population Density

regular surveys using trapping, surveillance
remote sensing technologies

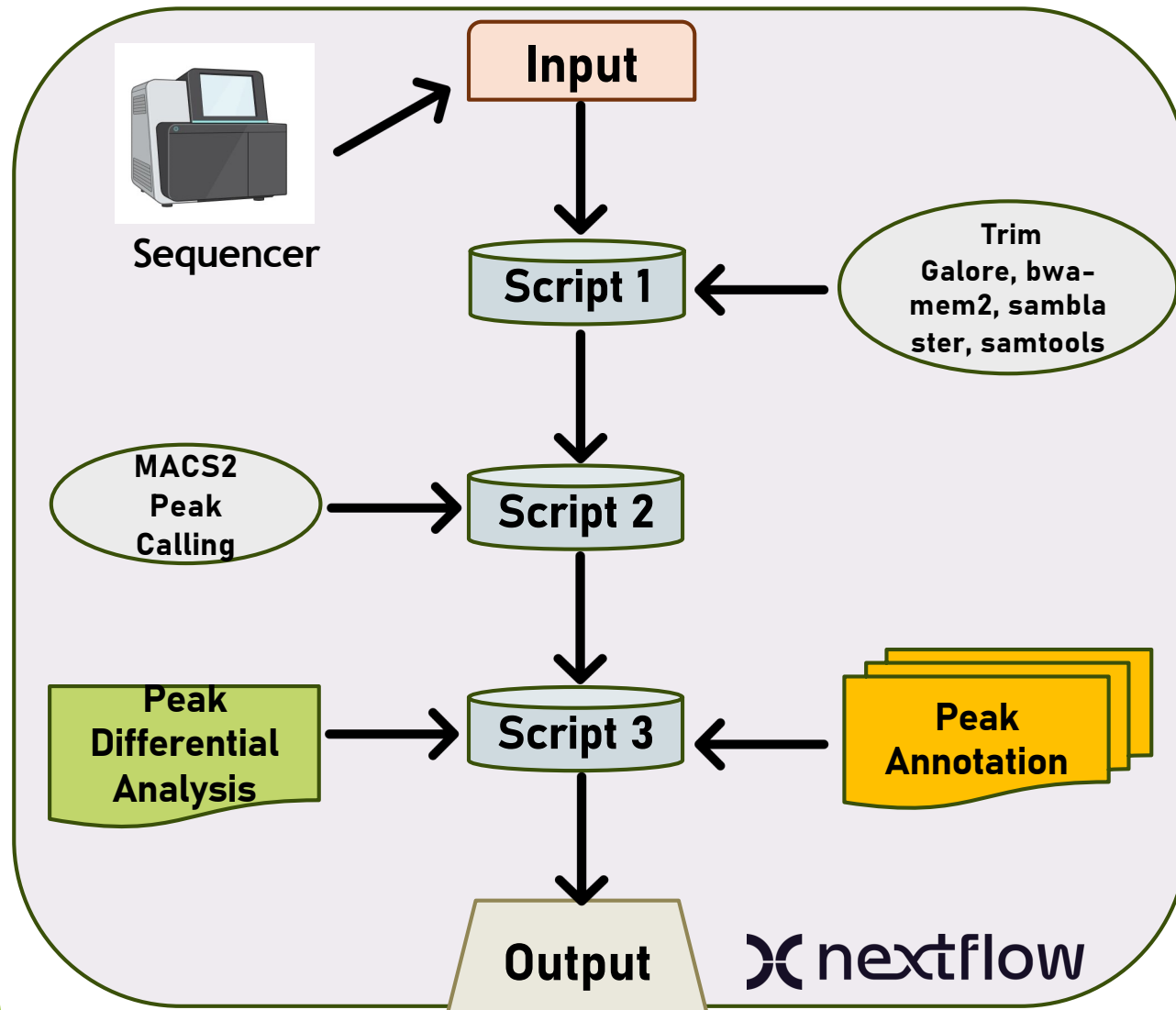


Evaluation Criteria for Impact Assessment

reductions in pest populations, crop damage

(Culbert *et al.*, 2020)

ATAC-Seq Pipeline Development at USDA-ARS



► What?

- Project: Sterile Insect Technique (SIT) - ATAC-Seq data analysis
- Objective: Identify regulatory elements active/inactive in male and female fruit flies (*Drosophila melanogaster*)

► Why?

- Purpose: Enhance SIT efficiency by manipulating gene expression related to insect reproduction

► How?

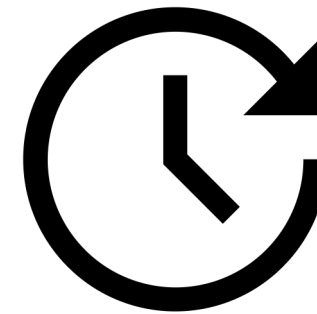
- Tools: HPC, Slurm (Job scheduler), bwa-mem2, Trim Galore, samblaster, samtools, Macs2, ChIPseeker, Nextflow
- Analysis: ATAC-Seq data processing, peak calling (MACS2), differential peak analysis (csaw), and annotation and visualization (ChIPseeker)

► End Goal?

- Application: Develop targeted strategies for controlling insect populations using SIT, leading to effective pest management
- reduced reliance on chemical pesticides

Future Directions for Research and Innovation in SIT

- ▶ Advance genetic technologies and breeding strategies
 - ▶ development of sex separation techniques
 - ▶ genetic sexing strains
- ▶ Novel delivery methods and release strategies
 - ▶ aerial release systems
 - ▶ spatial targeted deployment
- ▶ Integrate SIT with complementary pest management approach
 - ▶ biological control
 - ▶ habitat modification
 - ▶ attract-and-kill strategies



References

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