

# Collectives

EES 4760/5760

Agent-Based and Individual-Based Computational Modeling

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# Wild Dog Model

See the [downloads page](#) or Brightspace.

[https://ees4760.jonathangilligan.org/models/class\\_19/class\\_19\\_models.zip](https://ees4760.jonathangilligan.org/models/class_19/class_19_models.zip)

# Breeds of Turtles

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```
breed [dogs dog]
```

```
breed [cats cat]
```

```
globals []
```

```
turtles-own
```

```
[
```

```
  sex
```

```
  age
```

```
]
```

```
dogs-own
```

```
[
```

```
  has-ball?
```

```
]
```

```
cats-own
```

```
[
```

```
  has-scratching-post?
```

```
  claw-length
```

```
]
```

# Breeds and Contexts

- All breeds are evaluated in turtle context.

```
to go
  tick

  ask turtles [ set age age + 1 ]
  ask dogs [ if has-ball? [ fetch ] ]
  ask cats [ if has-scratching-post? [ scratch ] ]
  ask turtles [
    ; this will make an error
    if has-scratching-post? [ scratch ]
  ]
end
```

- Common error: Ask one breed (wolf) to do another breed's (sheep's) function.

# Checking for Errors:

Good idea: Check that the right breed is calling the function:

```
to do-cat-stuff
  if not is-cat? self
  [
    print (word "Error: turtle " self " is not a cat.")
    stop
  ]

  if has-scratching-post? [ scratch ]
end
```

Or, if you're using [jg-tif.nls](#), you can do this:

```
to do-cat-stuff
  test-that (word "do-cat-stuff: turtle " self " should be a cat.")
  expect-that is-cat? self is-true

  if has-scratching-post? [ scratch ]
end
```

# Turtles vs. Breeds

- If you have breeds, there will still always be `turtles`.
- `ask turtles [...]` will ask all breeds of turtle.
- `ask dogs [...]` will only ask the dogs.
- Many `turtles-` commands have a breed-specific version:

```
if any? turtles-here
[
  ask turtles-here [forward 10]
]

if any? dogs-on neighbors and any? cats in-radius 5
[
  ask dogs-on neighbors
  [
    chase min-one-of cats [distance myself]
  ]
]
```

# Breeds of links

- Links can also have breeds.

```
undirected-link-breed [friendships friendship] ; between friends
directed-link-breed [children-of child-of] ; from parent to children
directed-link-breed [employees employee] ; from boss to employees

to befriend [ new-friend ]
  create-friendship-with new-friend ; create friendship
end

to breed [ n ] ; executed in context of parent
  create-turtles n [
    create-child-of-from myself ; points from parent to new turtle
  ]
end

to hire [ employee-set ]
  create-employees-to employee-set
end
```



# More about Breeds

- You can change the breed of a turtle or link with `set-breed`:

```
ask one-of cats [ set breed dog ]  
ask one-of friendships [ set undirected-link-breed enmities ]
```

- You can specify the default shape of new individuals of a breed (doesn't affect any already created)

```
set-default-turtle-shape "circle"  
create-cats 1 ; default turtle shape  
  
set-default-shape cats "cat"  
set-sefault-shape dogs "dog"  
create-cats 1 ; has "cat" shape  
  
ask one-of cats [ set breed dogs ] ; cat becomes a dog and changes shape  
to "dog"
```

- **Note:** some shapes, like “cat” and “dog” must be imported into the model from the shapes library, using the shapes editor

# Wild Dog Model

# Wild Dog Model



- Adapted from Markus Gusset *et al.*, “Dogs on the Catwalk: Modelling Re-Introduction and Translocation of Endangered Wild Dogs in South Africa.”  
Biological Conservation **142**, 2774–81 (2009).

# Survival of endangered wild dogs (*Lycaon pictus*) in South African nature reserves.

- Dogs form packs
- Dogs in packs have social structure:
  - **Alpha:** One male, one female
  - **Subordinate adults**
  - **yearling** (1–2 years old)
  - **pup** (<1 year old)
  - When juvenile dogs reach adulthood, if they can't be dominant (alpha): decide whether to
    - leave pack (disperse), either alone or with adult siblings of same sex,
    - or stay and hope to become alpha one day.
- When dogs disperse from a pack, they form single-sex disperser groups of one or more disperser dogs.
  - All the dispersers of a given sex that leave a pack in the same tick form a disperser group.
  - When opposite-sex disperser groups meet, if they are not from same birth-pack, they may join and form a new pack.
- Disperser dogs have very high mortality rates.

# Detailed rules:

- Dispersal:
  - Two or more subordinates of same sex: always disperse
  - One subordinate of its sex: 50% probability to disperse
- Mortality (probability of dying each tick)

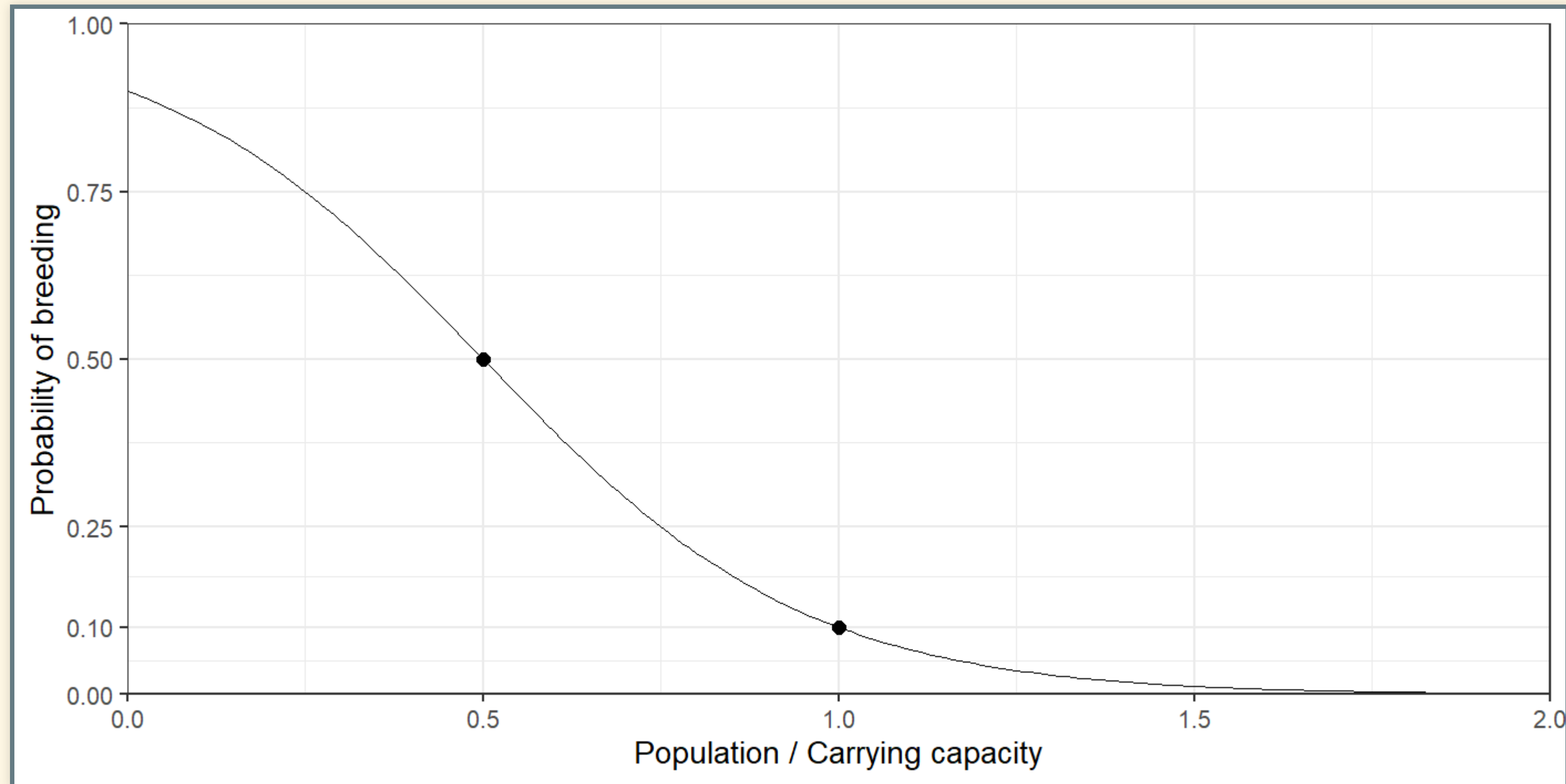
Status	Mortality
Pup	12%
Yearling	25%
Subordinate or alpha	20%
Disperser	44%

# Management Options

- Increase size of park:
  - Larger park has greater carrying capacity
  - Larger park makes it harder for disperser groups to meet.
- Decrease mortality of dispersers.

# Characteristics of Dogs

- Frequency of breeding depends on ratio of population to carrying capacity:



- When population is 50% of carrying capacity, probability of breeding is 50%
- When population is 100% of carrying capacity, probability of breeding is 10%

# Programming aspects

- Lots of things to keep track of.
- At end of each tick:
  - Social status must match age
  - A pack can have at most one alpha of each sex
  - A pack can't have subordinates without an alpha of that sex (they would become alpha)
  - A pack can't have more than one subordinate of each sex (they would disperse)
  - All dogs in disperser packs have status "disperser"
- Good to implement consistency checks to make sure packs and dogs follow these rules.



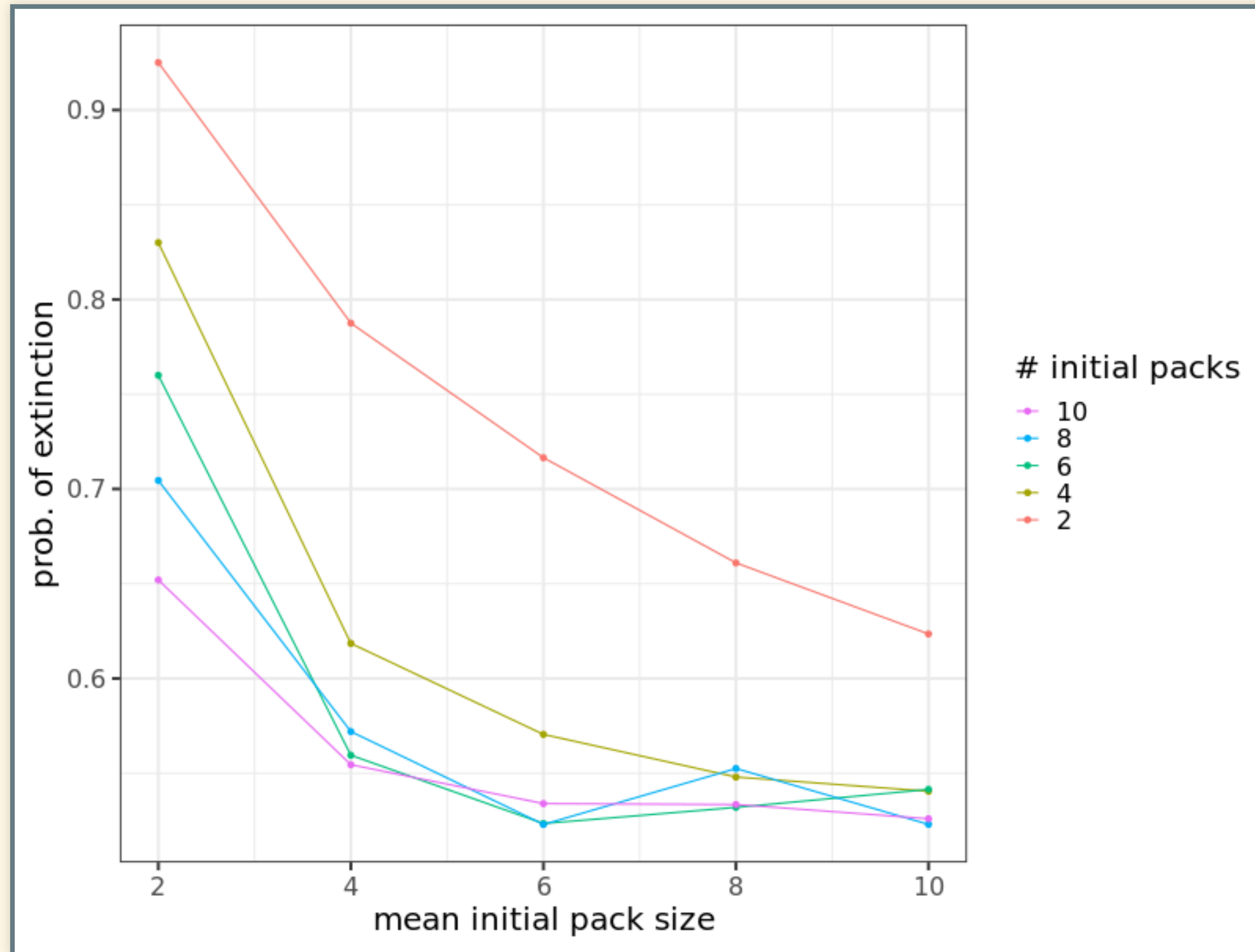
# Calculating Probability of Extinction within 100 years

```
to go
  if ticks >= years-to-simulate or not any? dogs
  [
    if ticks < years-to-simulate
    [
      set time-to-extinction ticks
      set extinct? true
    ]
    stop
  ]
  step ; "step" does all the work of mating, aging, dispersing, dying, etc.
end
```

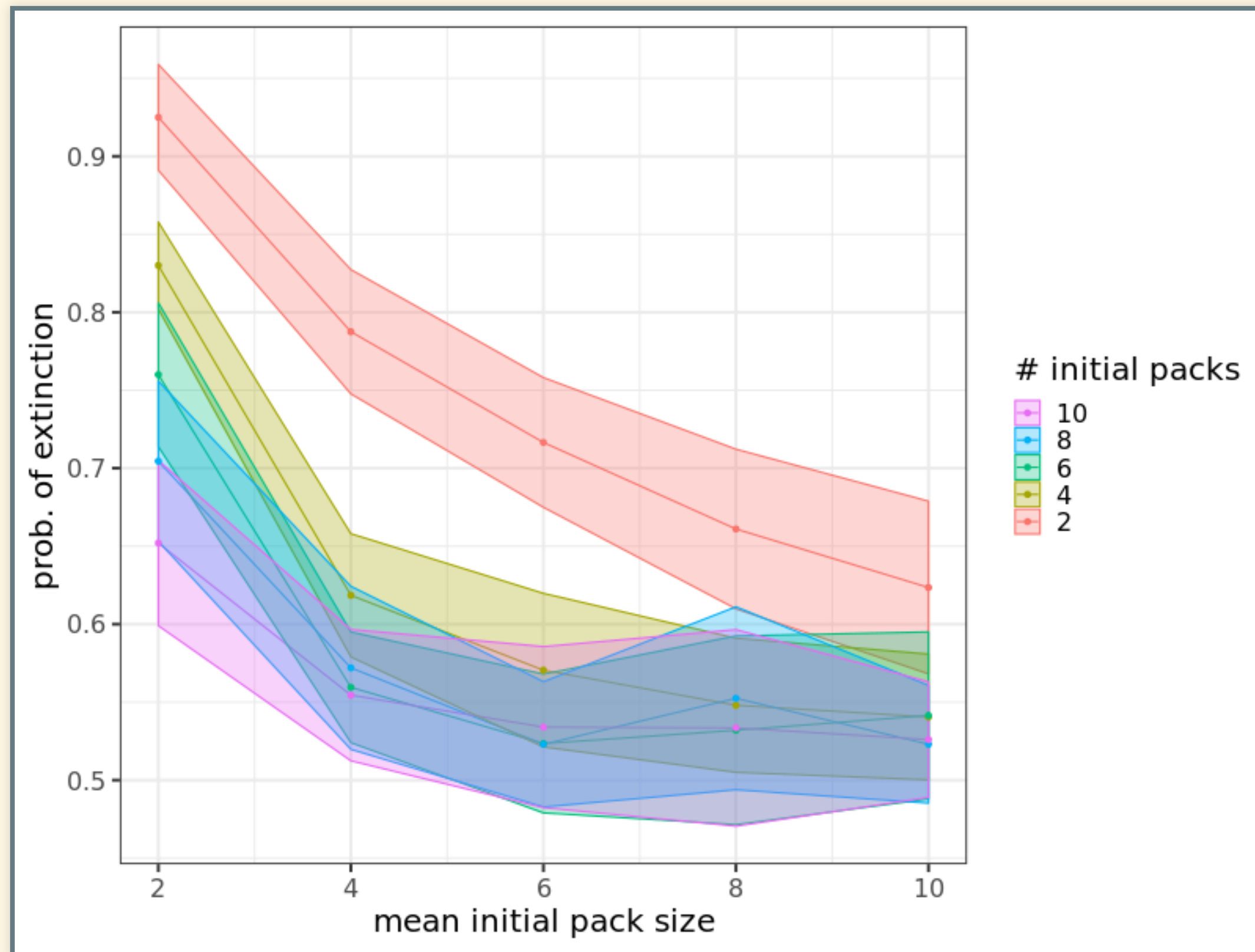
```
to get-p-extinct [ n-runs ]
  let n-extinct 0
  repeat n-runs
  [
    setup
    while [ticks < years-to-simulate and not extinct?] [ go ]
    if extinct? [ set n-extinct n-extinct + 1 ]
  ]
  set p-extinction n-extinct / n-runs
end
```

# Behaviorspace Experiments

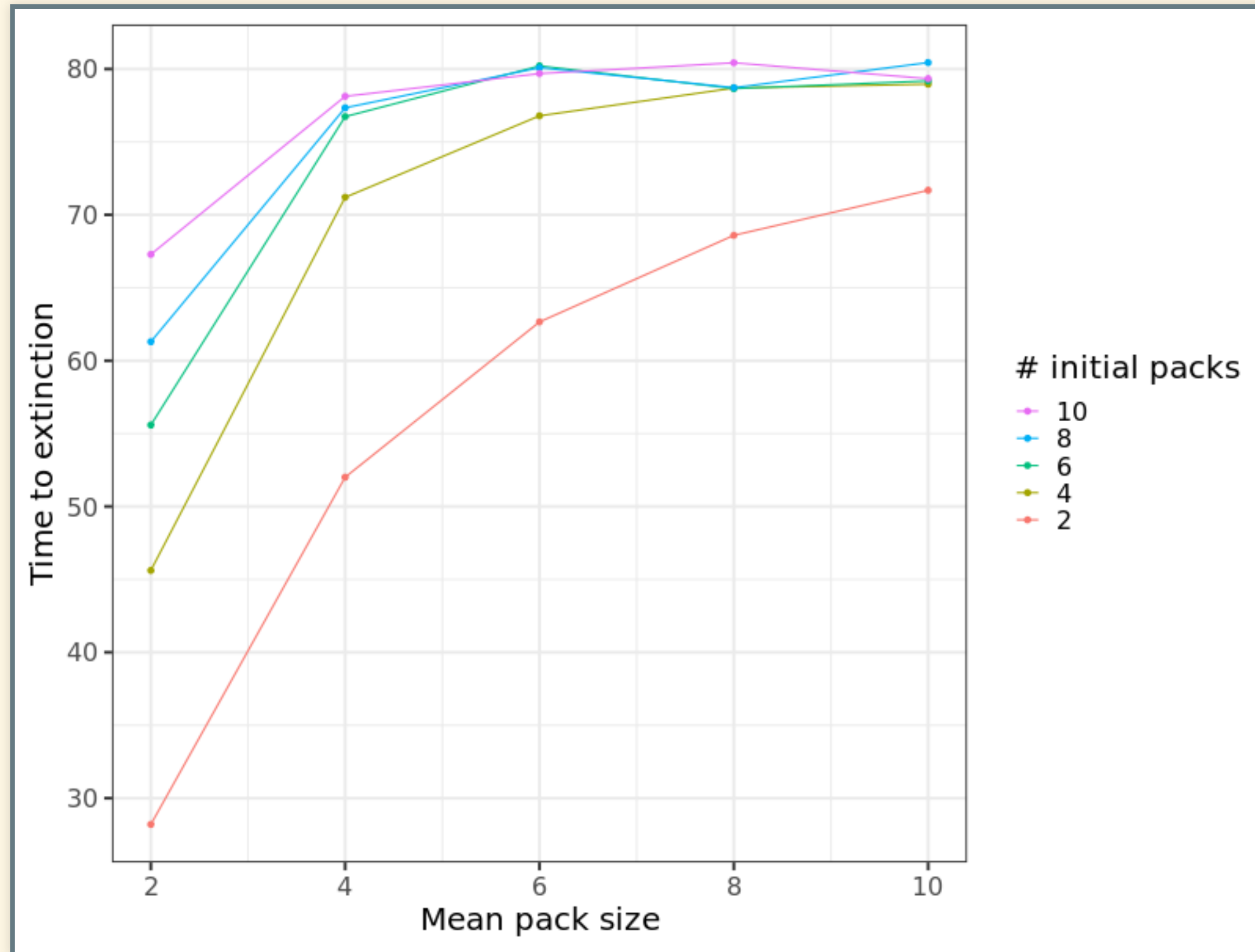
# Vary Initial Conditions



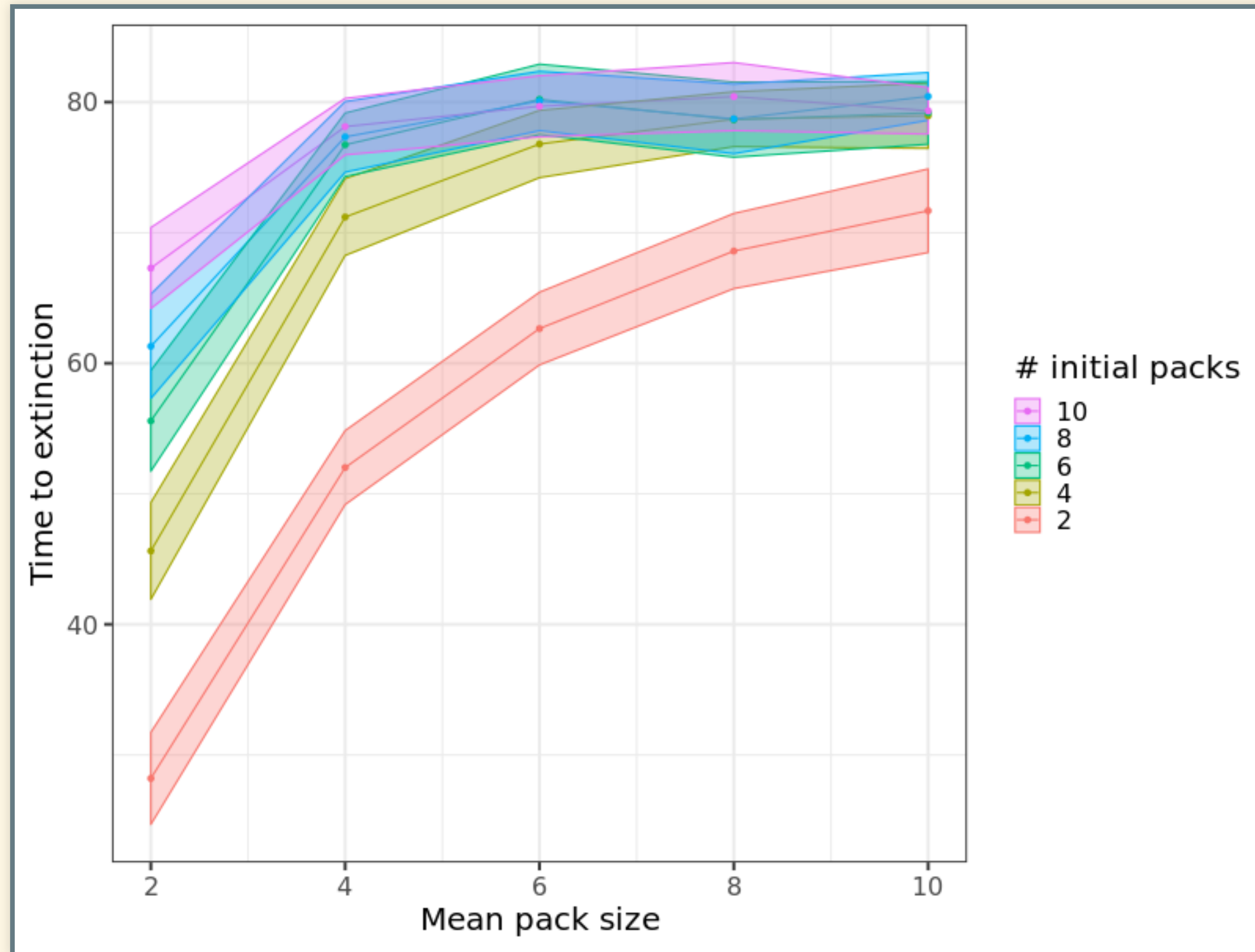
# Vary Initial Conditions



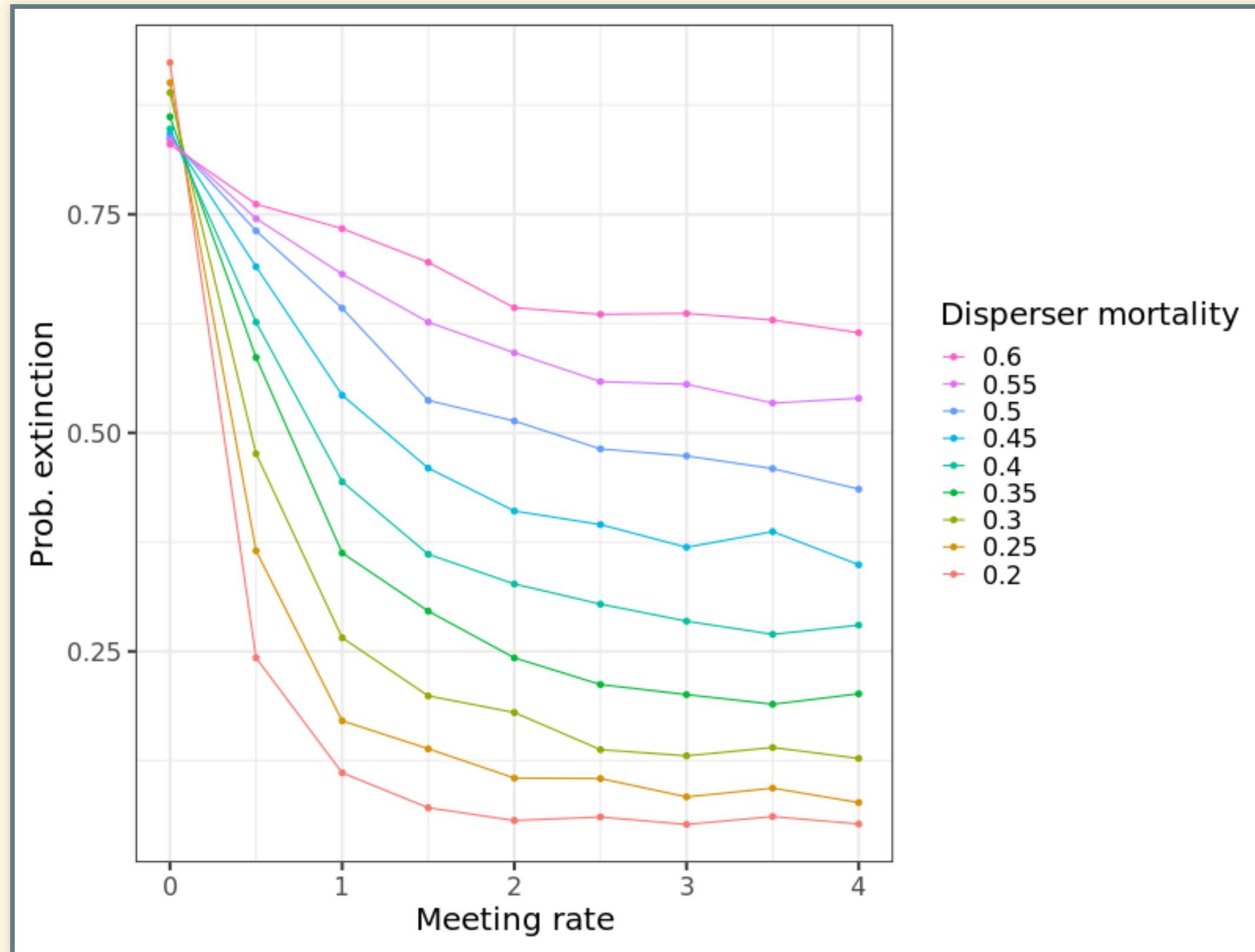
# Mean time to extinction



# Mean time to extinction



# Vary Disperser Group Meeting Rate



# Vary Disperser Group Meeting Rate

