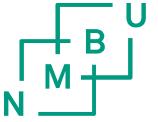


Modelling the ecosystem of Rossumøya

INF200 Gruppe 09 ved REALTEK, NMBU

27.01.2020

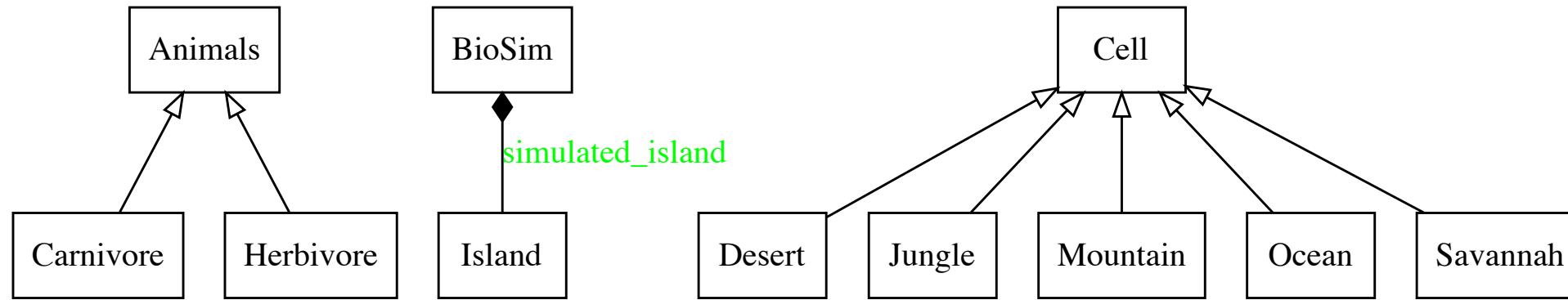


Hvordan har vi løst det?

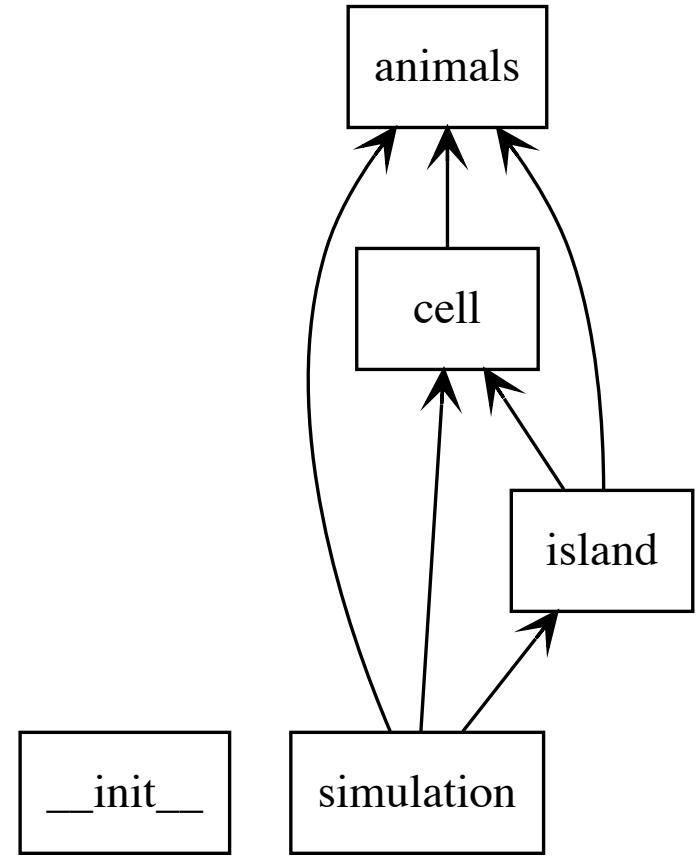
Våre mål:

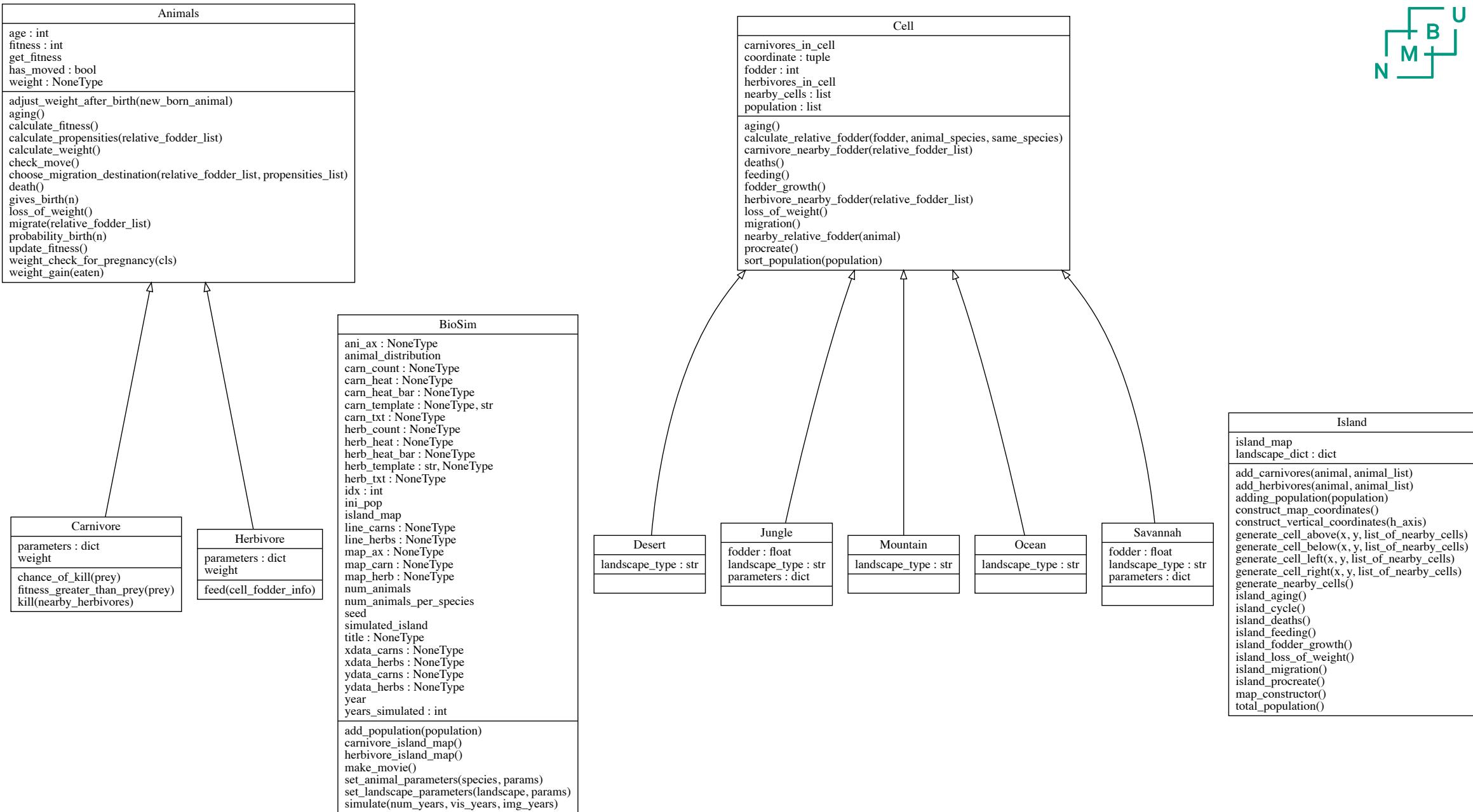
- Håndtere operasjoner i moduler der de hører logisk hjemme
- Unngå i størst mulig grad å oppbevare informasjon på flere steder
- Intuitiv og lesbar kode. Fokus på beskrivende variabel- og funksjonsnavn
- Holde kjøretid lav med *smart* kode

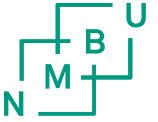
Våre klasser



N M B U







Animals

- Håndterer hvert enkelt dyr s operasjoner
- I klassen “Animals” lagres attributter om hvert dyr
 - Alder, vekt, form (fitness) osv.
- Klassen inneholder metoder som er felles for alle dyr
 - Fødsel, død, migrasjon, osv.

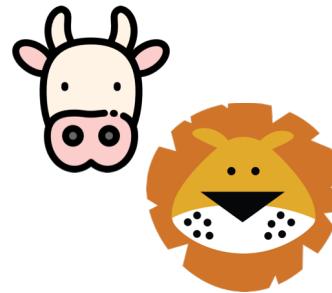
Herbivores

- Underklasse av "Animals"
- Klassen beskriver operasjoner og attributter som er unikt for denne typen dyr
 - Feeding



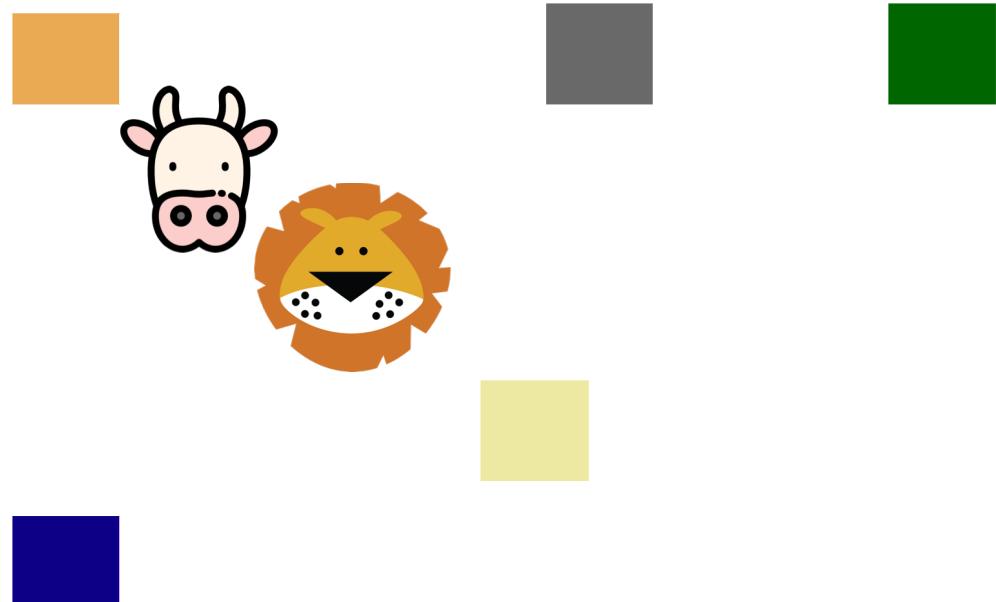
Carnivores

- Underklasse av "Animals"
- Klassen beskriver operasjoner og attributter som er unikt for denne typen dyr
 - Feeding



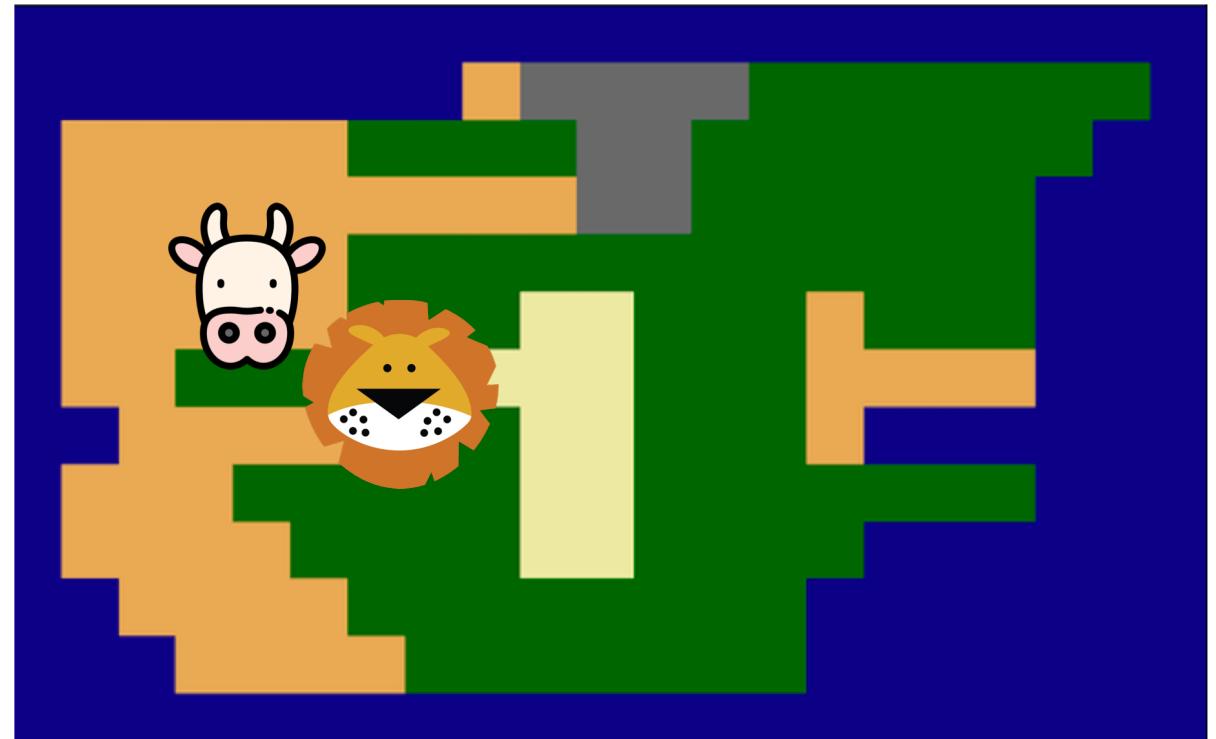
Cells

- Lager informasjon som tilhører hver enkelt celle
- Hver landskapstype er en underklasse av “Cell”
 - Desert, Savannah, Jungle, Ocean og Mountain
- Koordinat, populasjon og tilgjengelig mat er attributter for hver celle
- Celler i *nærheten*



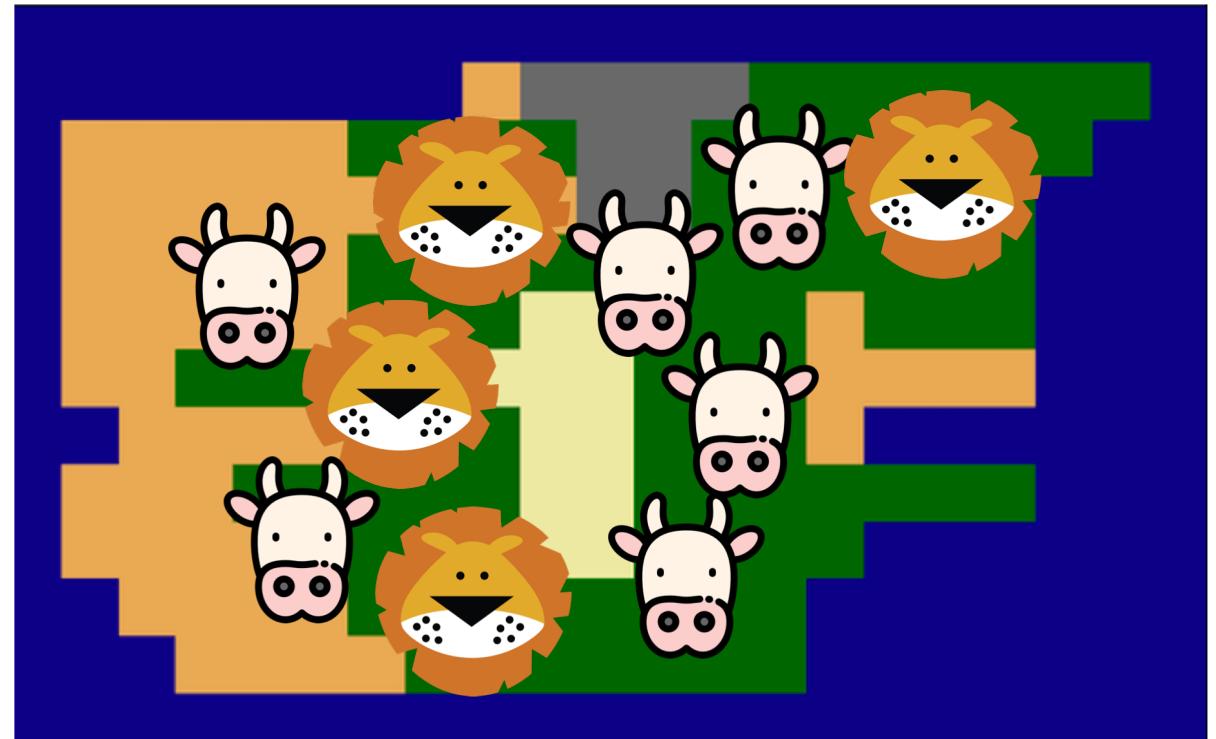
Island

- Lager informasjon som tilhører hele øya
 - Geografi
- Behandler hendelsene som skjer per år på øya
 - Dydrene blir eldre, dyrene migrerer, dyrene føder, osv.

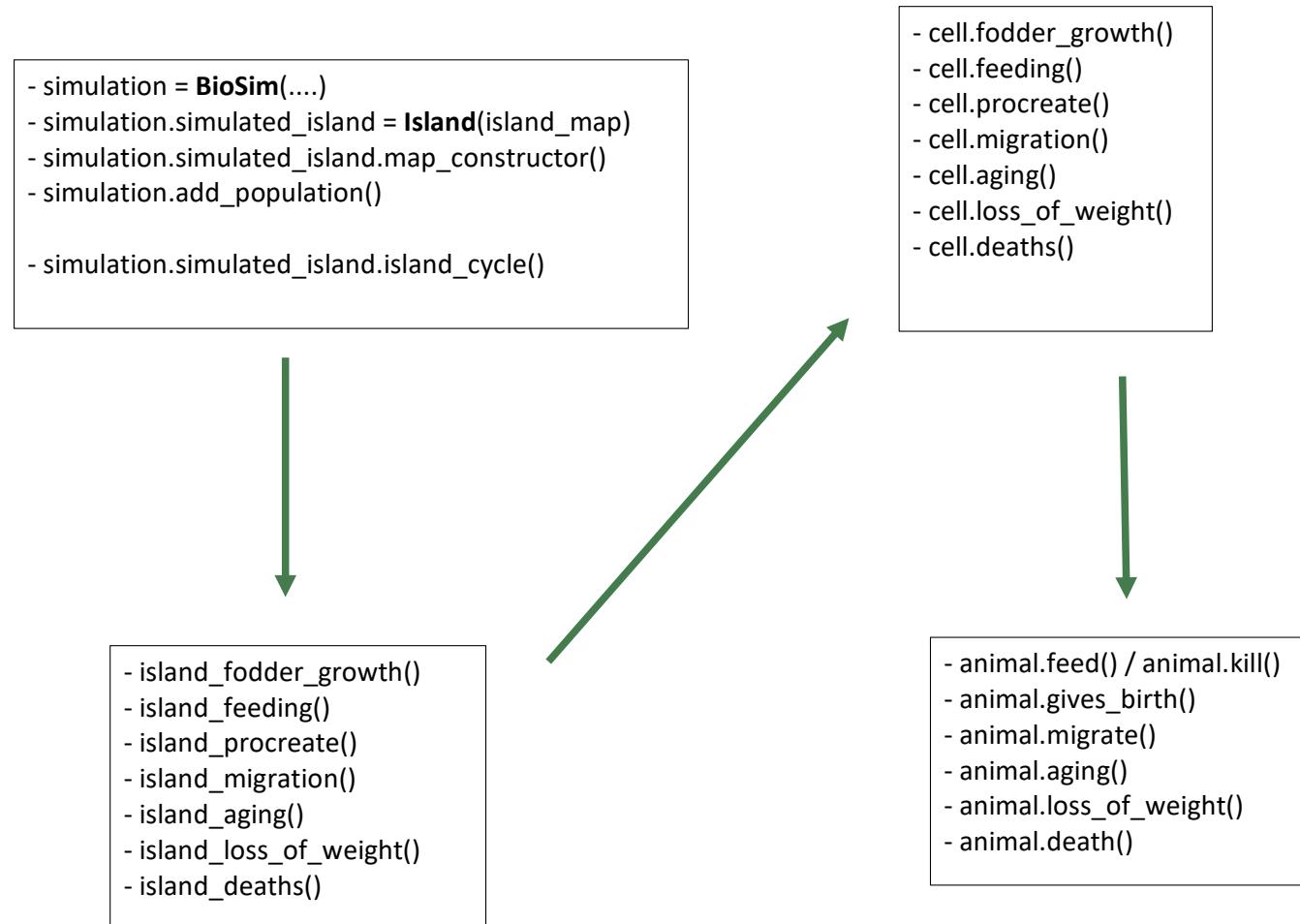


Simulation

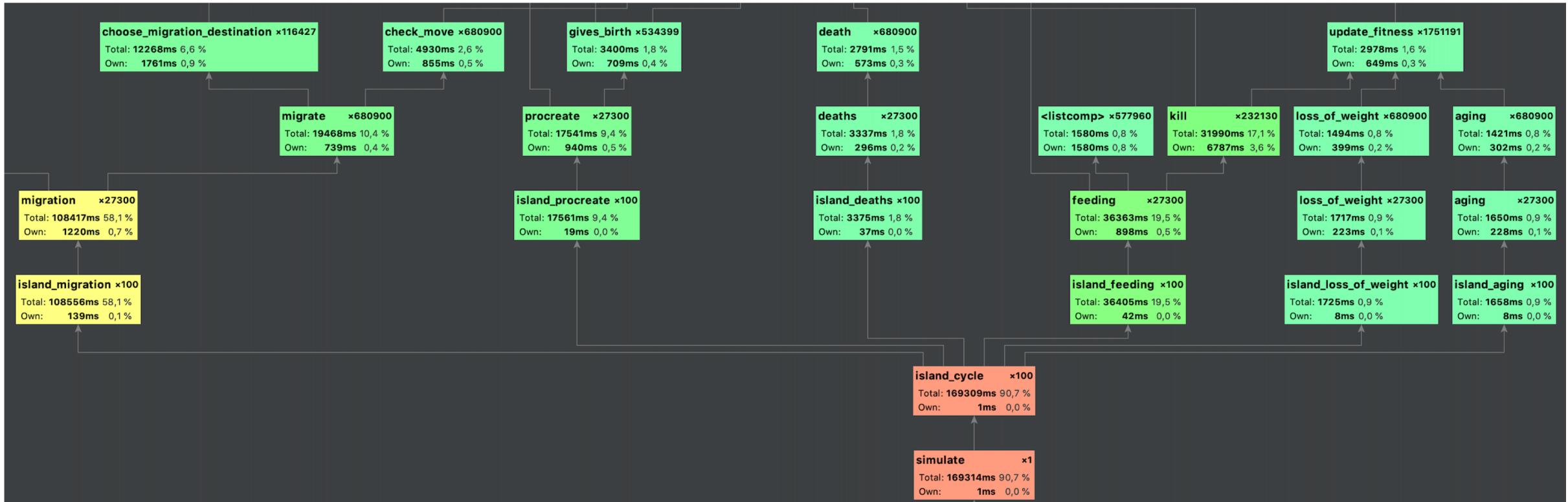
- Inneholder all informasjon til simuleringen og visualisering
- Selve simuleringen finnes her



Sammenheng mellom metoder i en simulering

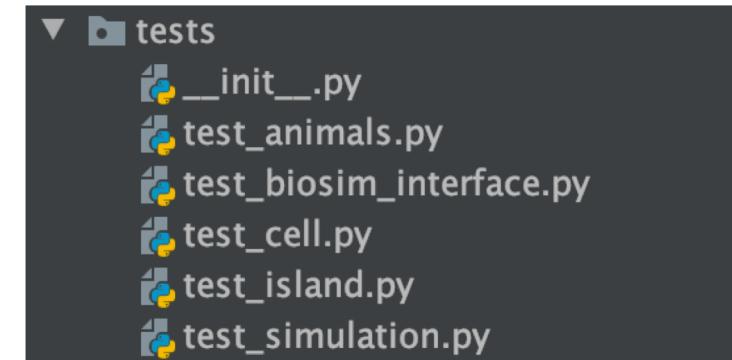
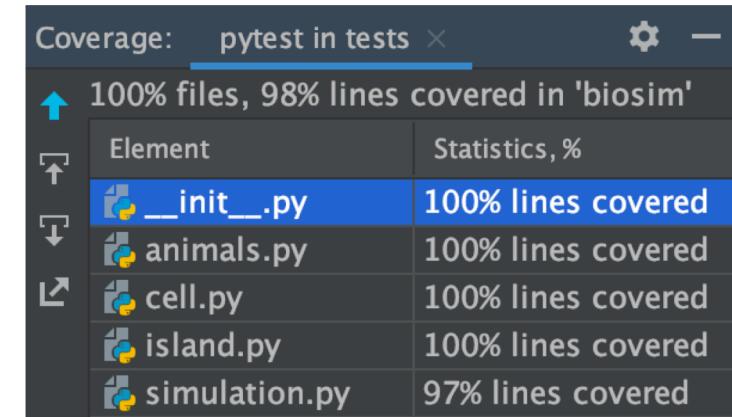


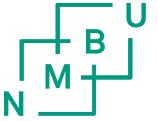
Sammenheng mellom metoder i en simulering



Koden utfører oppgavene som forventet

- I prosjektet har vi totalt 118 tester
- Disse dekker 98% av kodelinjene i vår «biosim»-pakke



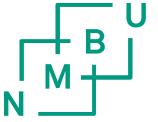


Hvordan har vi testet?

- Docstrings, tester, kode
- Test at alle metoder returnerer forventede verdier eller endringer
- Testet at alle klasser konstrueres korrekt
- Testet at funksjoner blir kalt korrekt antall ganger
- Statistiske tester for normalfordeling og binomialfordeling

```
def test_procreate(self):  
    """  
    Tests that 'Herbivore.gives_birth' is called an expected number of  
    times for herbivores in cell.  
    """  
    self.jungle_cell.population = self.herb_pop  
    self.jungle_cell.procreate()  
    assert self.mock_procreate.call_count == 4
```

```
▼ ✓ TestDeath  
  ✓ test_death_by_zero_fitness  
  ✓ test_death_with_max_fitness  
  ✓ test_probability_of_death  
▼ ✓ TestBirth  
  ✓ test_weight_check_for_pregnancy  
  ✓ test_probability_of_birth  
  ✓ test_adjust_weight_after_birth  
  ✓ test_gives_birth_low_weight_returns_none  
  ✓ test_gives_birth_no_birth_returns_none  
  ✓ test_parameters_reset  
  ✓ test_gives_birth_returns_newborn_herbivore  
  ✓ test_gives_birth_returns_newborn_carnivore  
▼ ✓ TestMigrate  
  ✓ test_check_move_return  
  ✓ test_migrate_returns_none_for_invalid_cells  
  ✓ test_migrate_to_valid_cell
```



En oversiktlig struktur

- Moduler med klasser som håndterer operasjoner
- Tydelige variabelnavn
- Fokus på kortere metoder og funksjoner
- Beskrivende docstrings, også i tester

Island



Cell



Animals

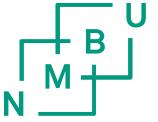
```
def island_deaths(self):
    """
    Yearly cycle for death. Checks for all animals on the island if they die.
    """
    for y in self.island_map:
        for cell in y:
            cell.deaths()
```

```
def deaths(self):
    """
    Checks whether an animal dies for all animals in cell. Dead animals are removed from the cell's population.
    """
    dead_animals = []
    for animal in self.population:
        if animal.death():
            dead_animals.append(animal)
    self.population = [animal for animal in self.population if animal not in dead_animals]
```

```
def death(self):
    """
    Determines whether an animal dies. The animal dies if the fitness of the animal is 0. The animal also has a probability of dying each year.

    Returns
    ----
    Bool
        'True' is the animal dies and 'False' otherwise.
    """

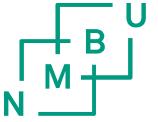
    if self.fitness == 0:
        return True
    elif bool(np.random.binomial(1, self.parameters['omega'] * (1 - self.fitness))) is True:
        return True
    else:
        return False
```



Men den kan forbedres

- Flaskehalsen:
 - List comprehensions
 - Numpy random binomial
 - «built-ins»

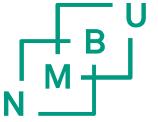
Name	Call Count	Time (ms) ▼
check_sim.py	1	186696 100,0 %
simulate	1	169314 90,7 %
island_cycle	100	169309 90,7 %
island_migration	100	108556 58,1 %
migration	27300	108417 58,1 %
nearby_relative_fodder	680900	87378 46,8 %
carnivore_nearby_fodder	271804	51720 27,7 %
island_feeding	100	36405 19,5 %
feeding	27300	36363 19,5 %
herbivore_nearby_fodder	409096	34855 18,7 %
<built-in method builtins.isinstance>	342692468	32648 17,5 %
kill	232130	31990 17,1 %
<listcomp>	1636384	31279 16,8 %
<method 'binomial' of 'numpy.random.>	8964853	30753 16,5 %
<listcomp>	1087216	21750 11,6 %
<listcomp>	1087216	20975 11,2 %
migrate	680900	19468 10,4 %
island_procreate	100	17561 9,4 %
procreate	27300	17541 9,4 %
<built-in method builtins.input>	1	15201 8,1 %
<listcomp>	534399	13087 7,0 %
choose_migration_destination	116427	12268 6,6 %



Men den kan forbedres

- Tiltak:
 - Flere tester
 - Numpy arrays
 - Mer effektiv kode
 - Metoder kan kalles kun dersom det er nødvendig
 - Bedre bruk av eksisterende data og metoder

Name	Call Count	Time (ms)	Own Time (ms) ▾
<built-in method builtins.instance>	342692468	32648 17,5 %	32647 17,5 %
<method 'binomial' of 'numpy.random.>	8964853	30753 16,5 %	30753 16,5 %
<listcomp>	1636384	31279 16,8 %	19851 10,6 %
<built-in method builtins.input>	1	15201 8,1 %	15201 8,1 %
<listcomp>	1087216	21750 11,6 %	13348 7,1 %
<listcomp>	1087216	20975 11,2 %	12492 6,7 %
<listcomp>	534399	13087 7,0 %	9170 4,9 %



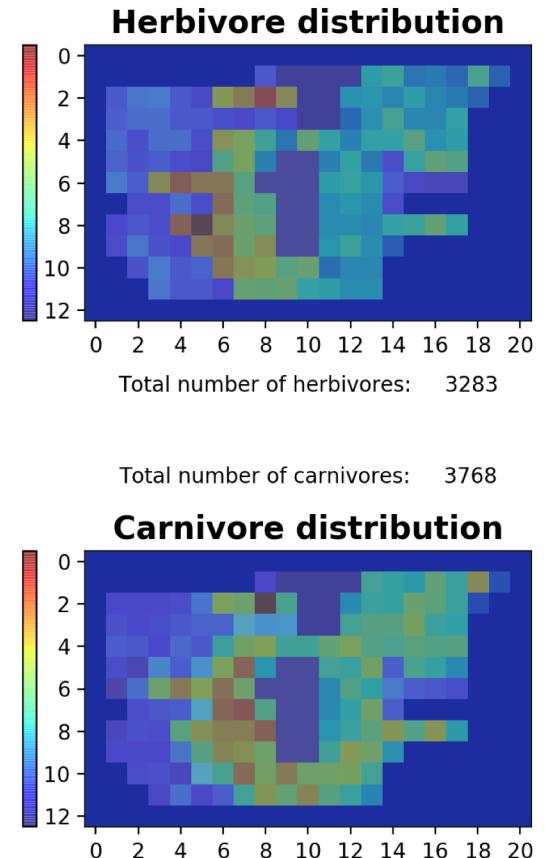
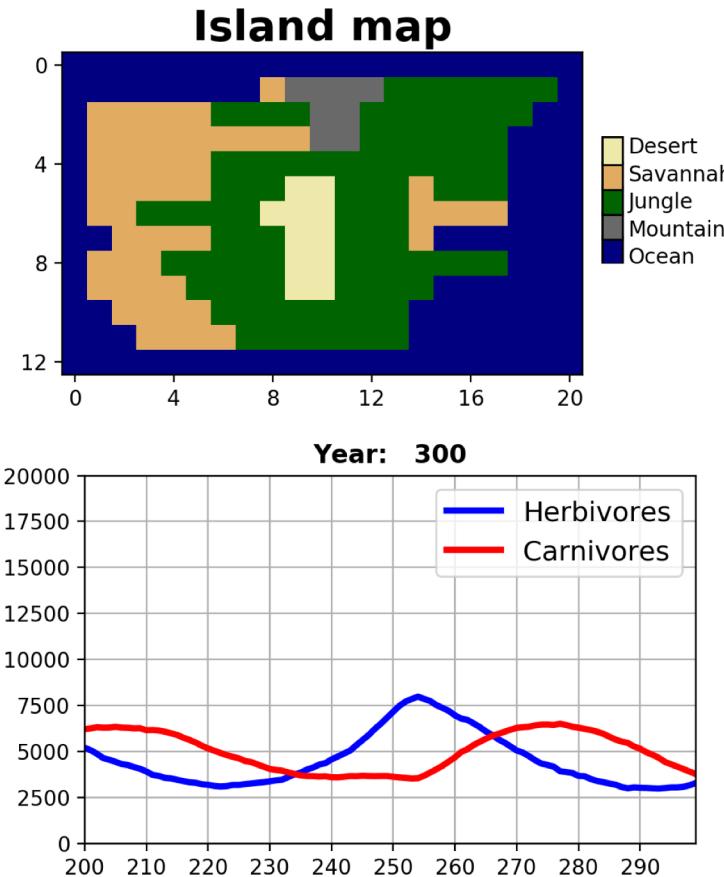
Ekstra funksjonalitet

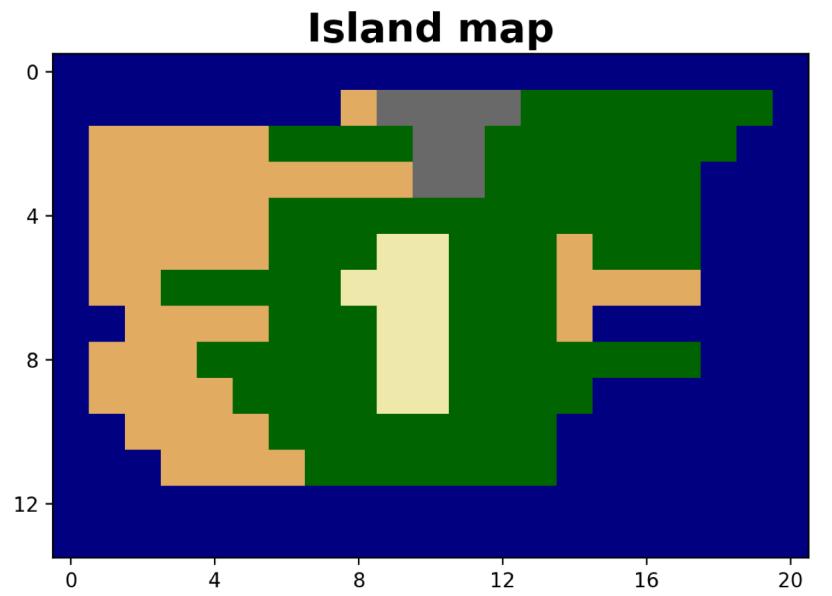
- Koden inneholder ingen ekstra funksjonalitet
- Muligheter for videre utvikling
 - Endringer til geografi
 - Modifikasjoner til sykluser på øya
 - Utvide *Animals*-modulen
 - GUI



Visualisering

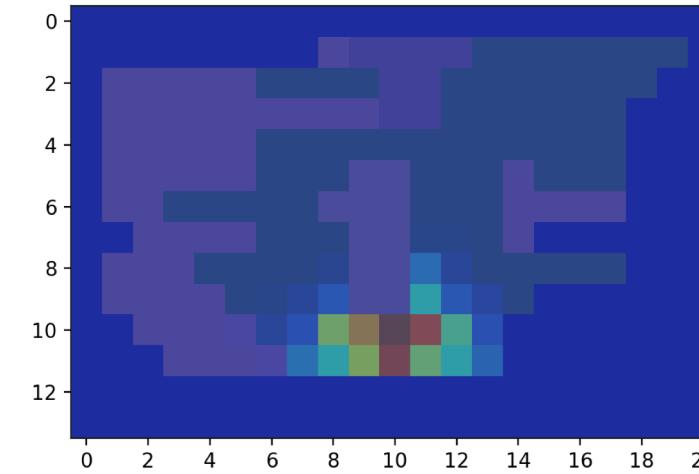
- Kart over Rossumøya
- Heat maps
- Graf og «counter» med antallet av «herbivores» og «carnivores»



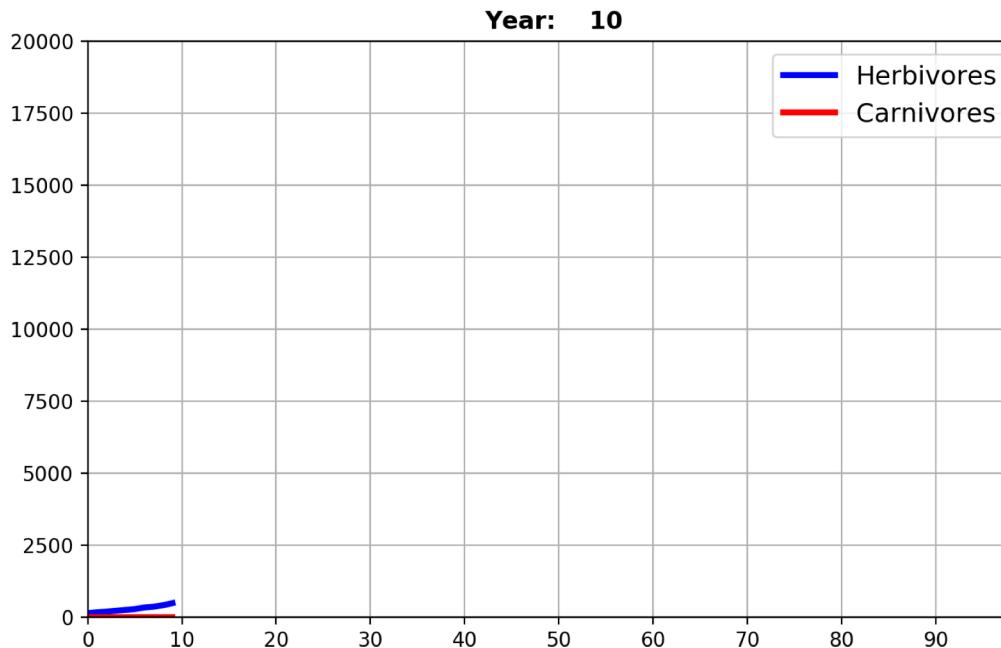
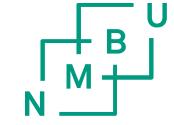


Desert
Savannah
Jungle
Mountain
Ocean

Herbivore distribution

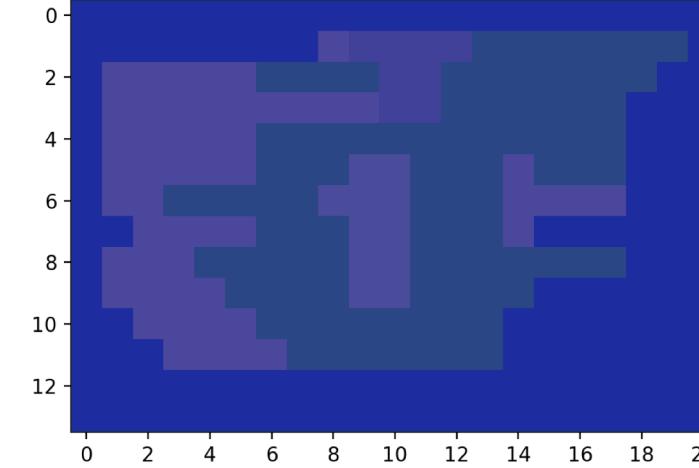


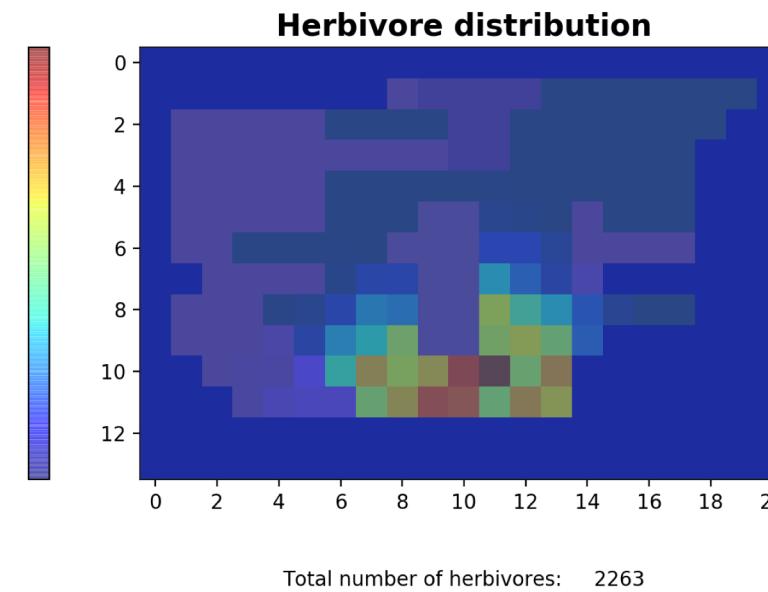
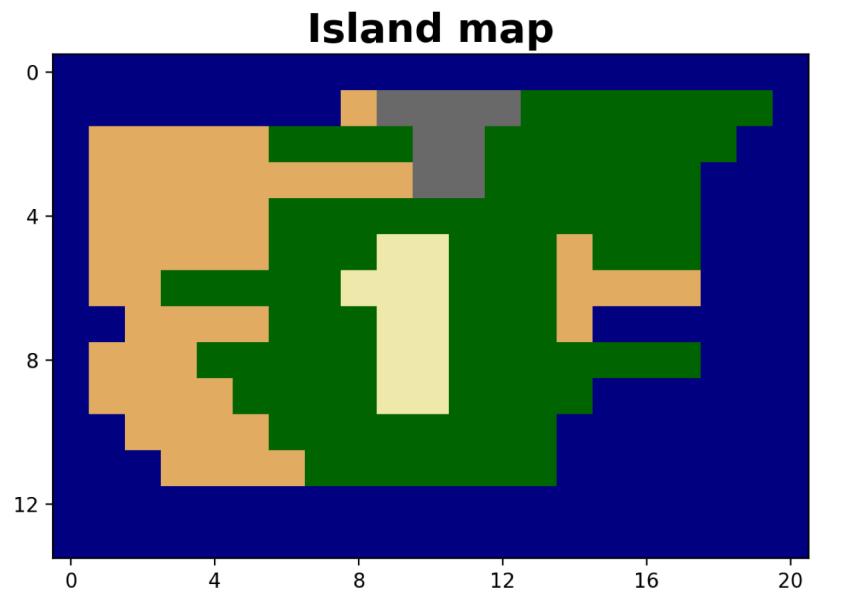
Total number of herbivores: 490



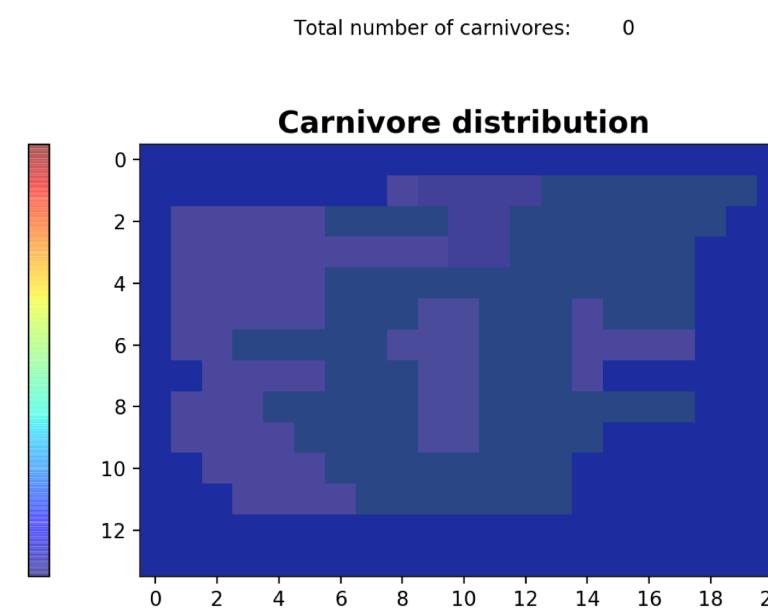
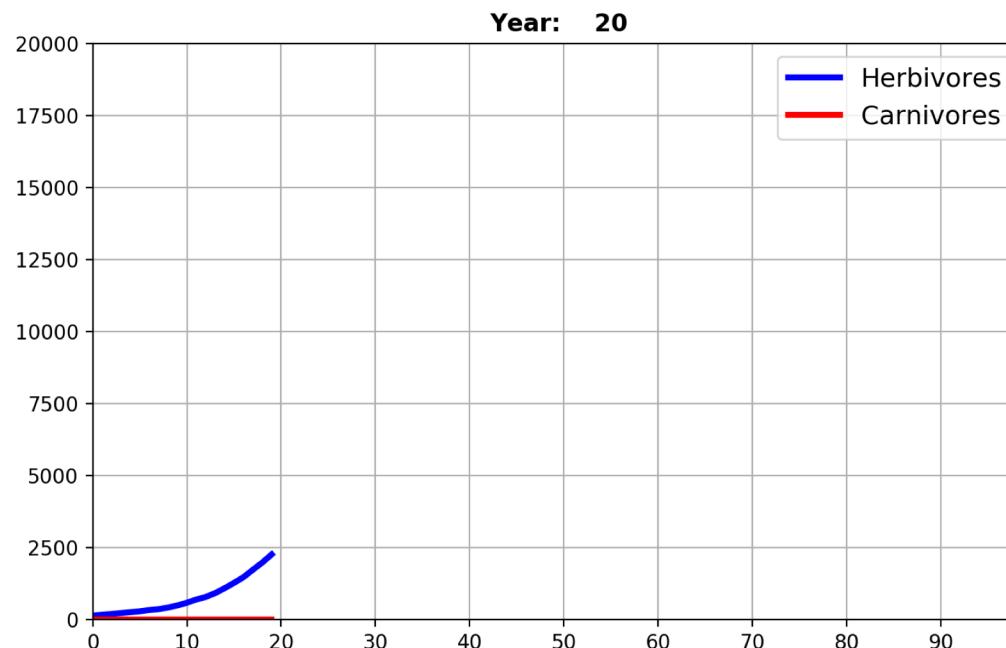
Total number of carnivores: 0

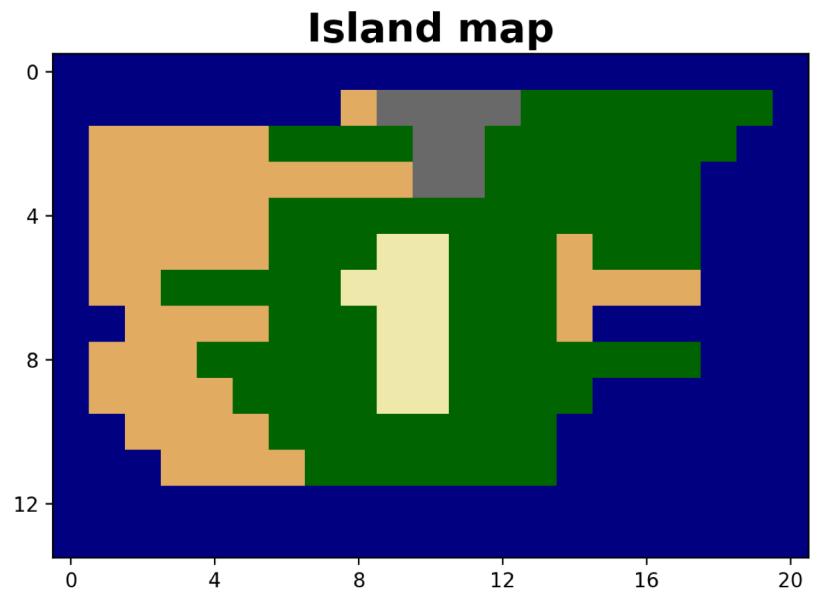
Carnivore distribution





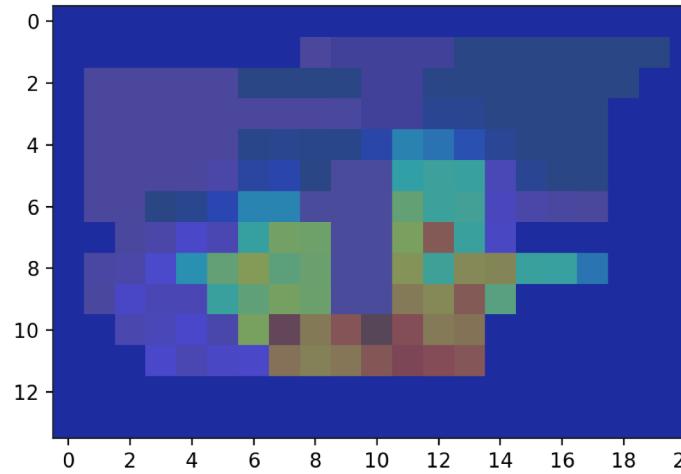
N M B U



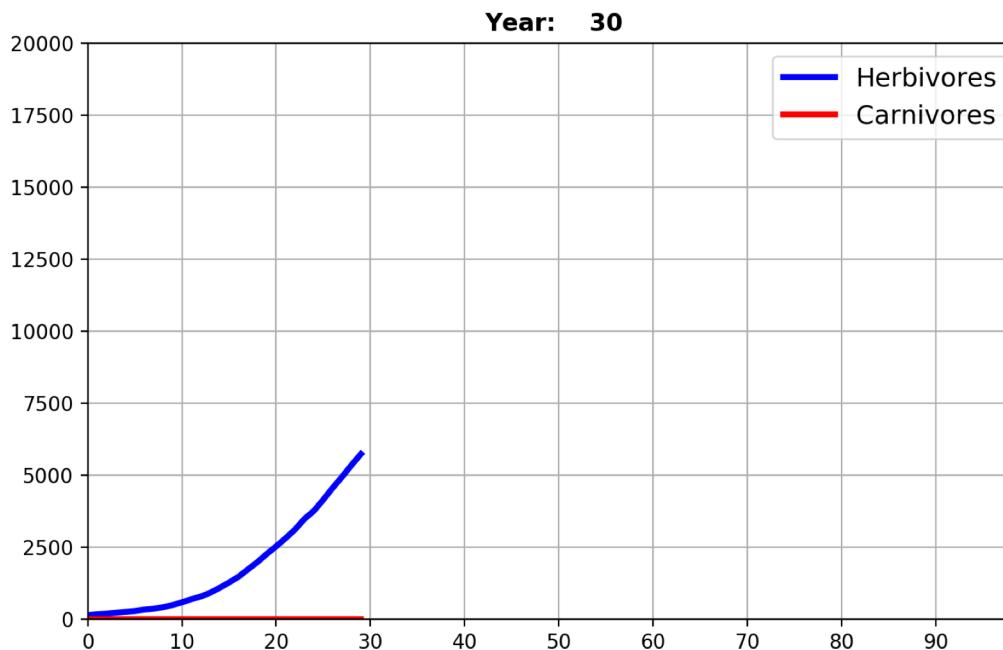
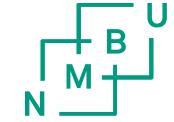


Desert
Savannah
Jungle
Mountain
Ocean

Herbivore distribution

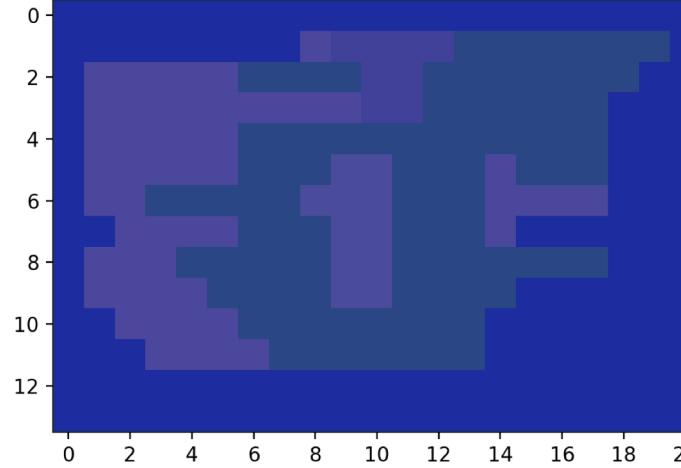


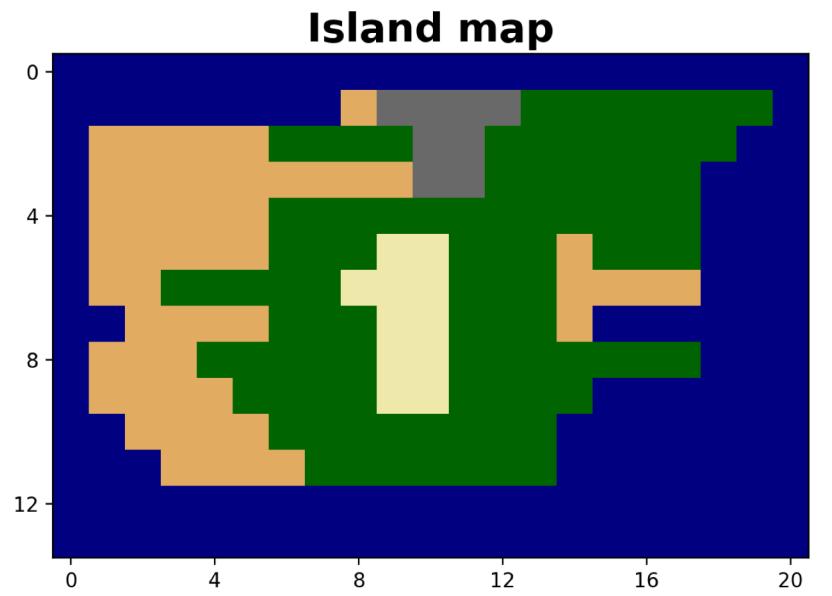
Total number of herbivores: 5735



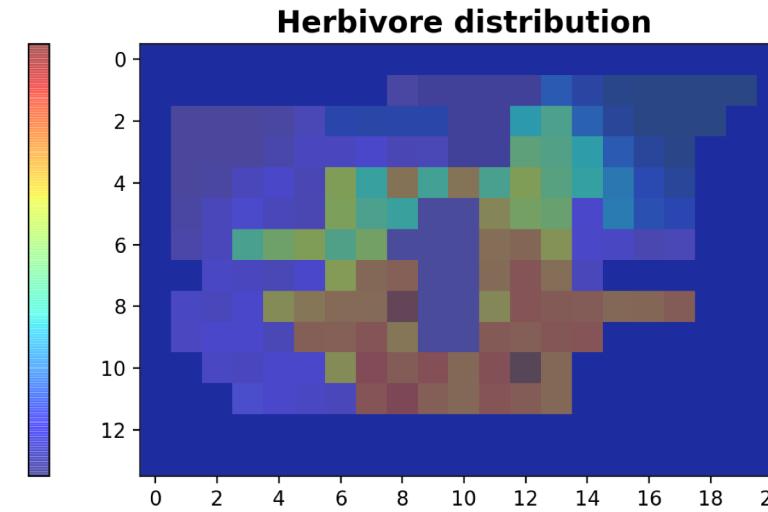
Total number of carnivores: 0

Carnivore distribution

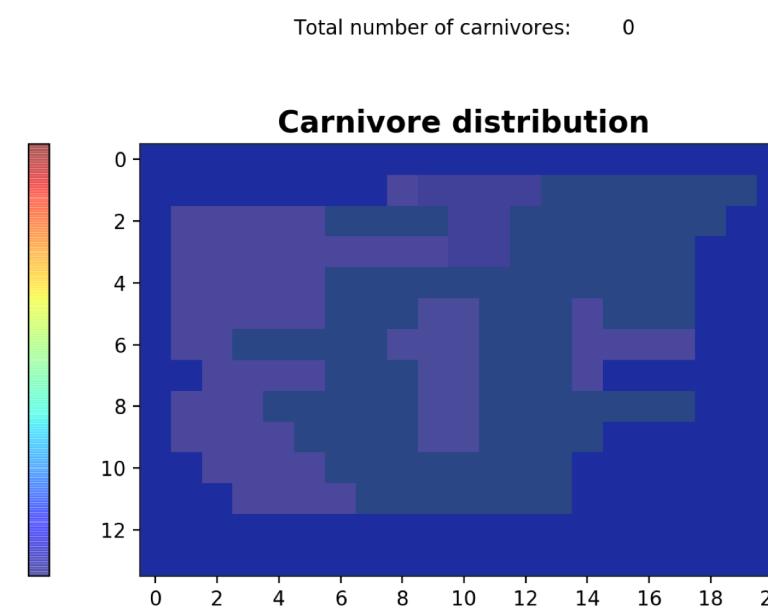
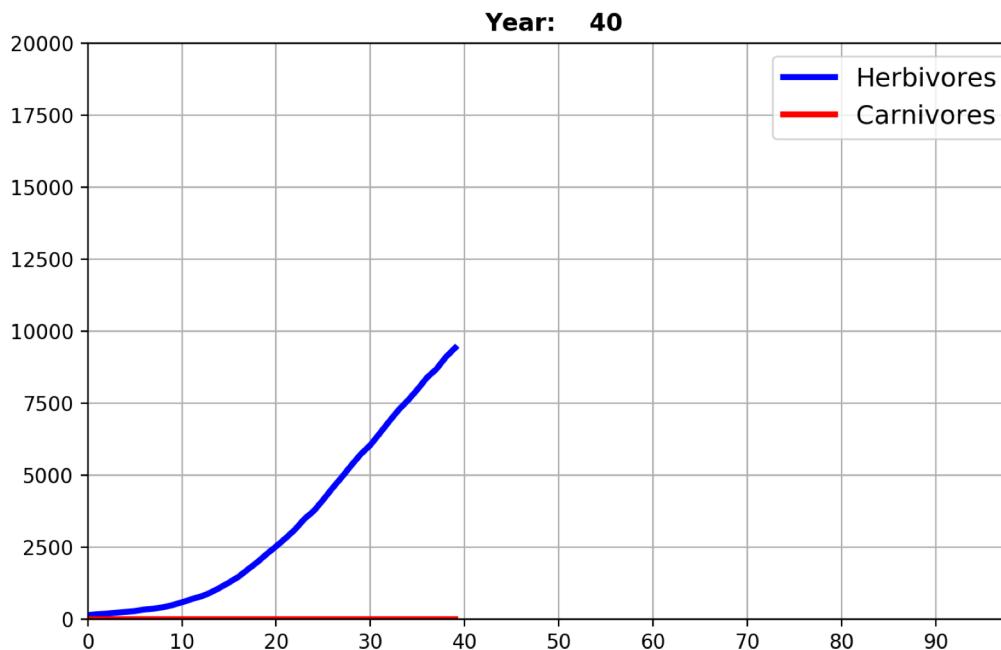
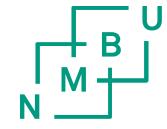




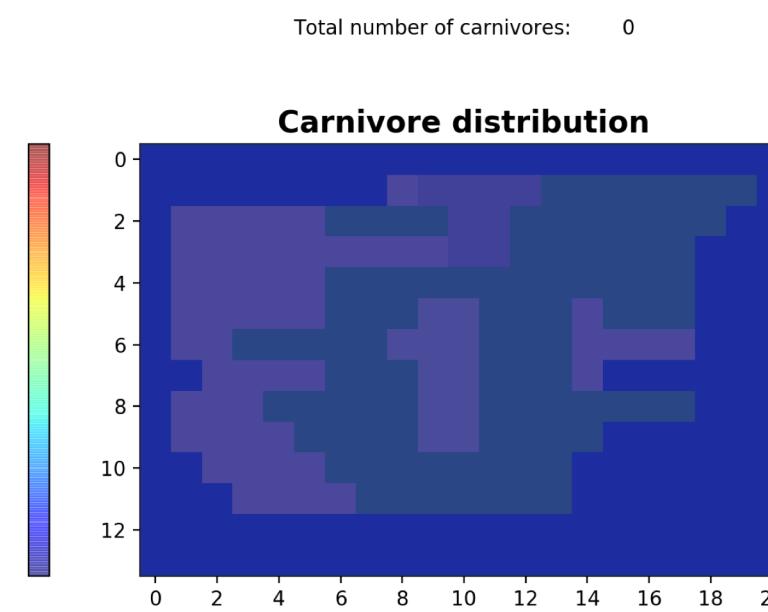
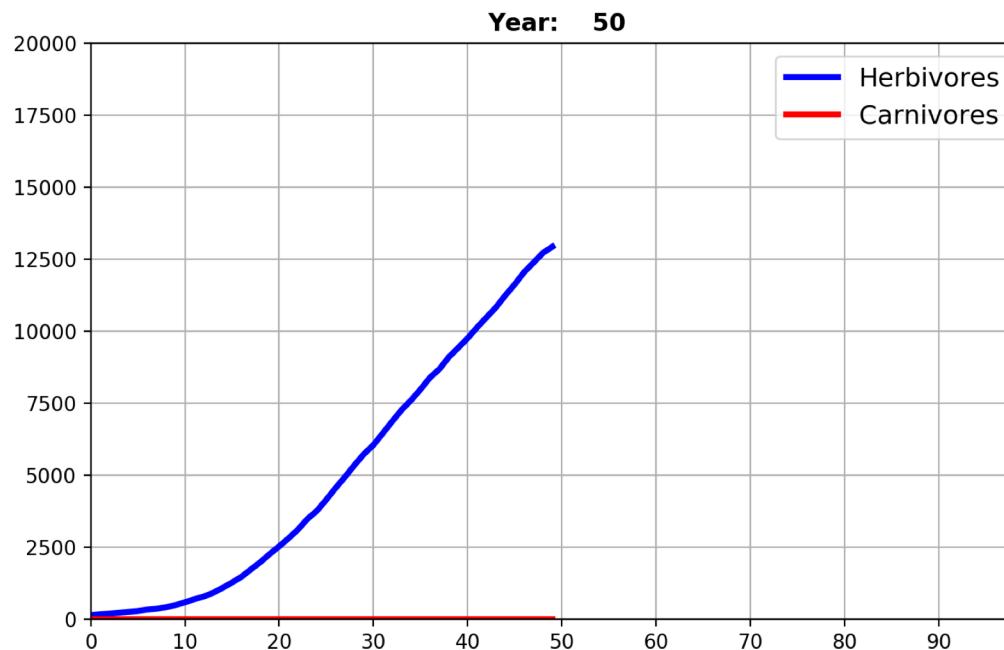
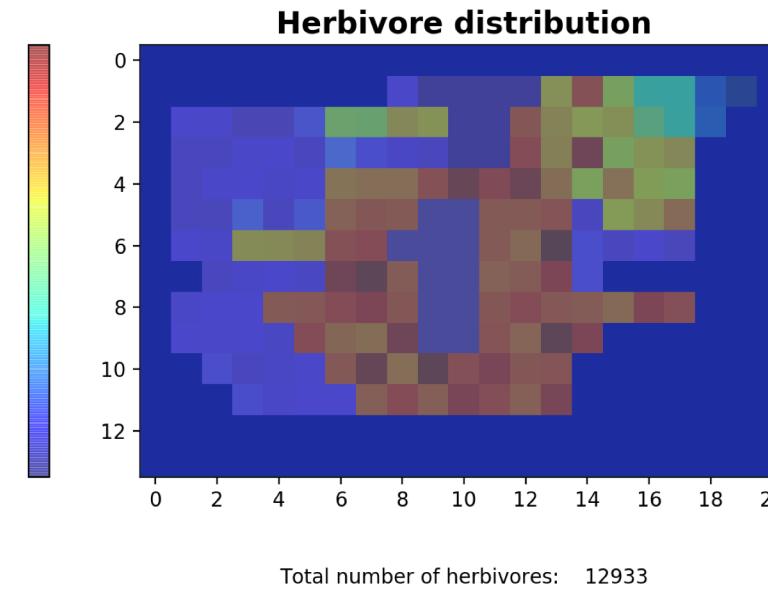
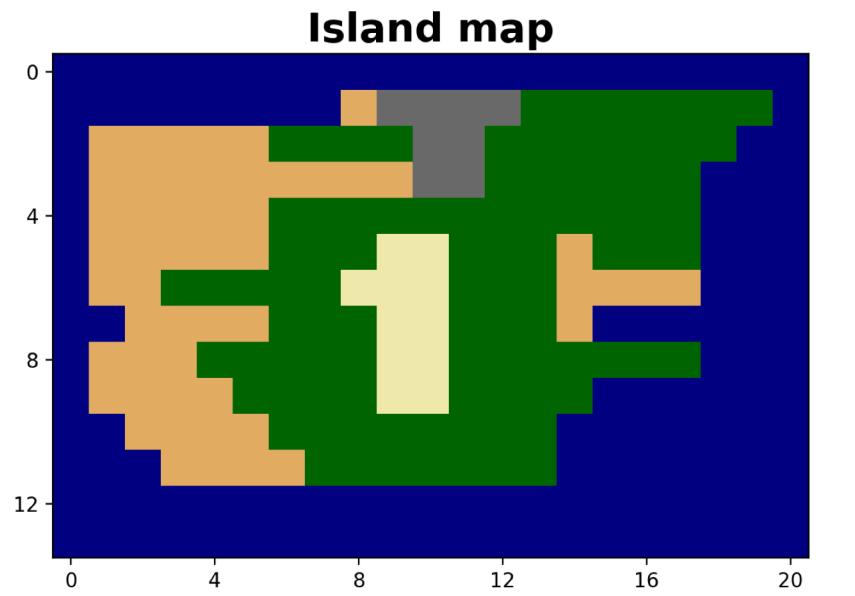
- Desert
- Savannah
- Jungle
- Mountain
- Ocean

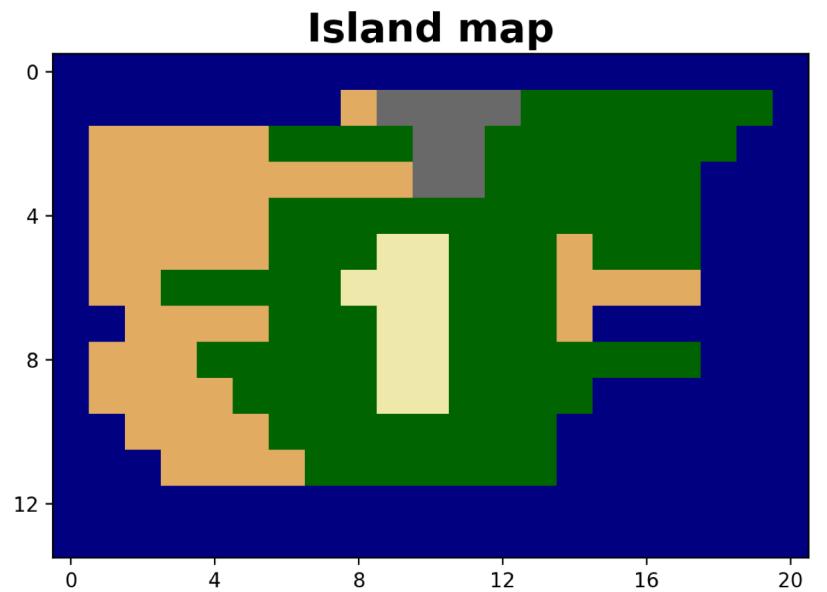


Total number of herbivores: 9423

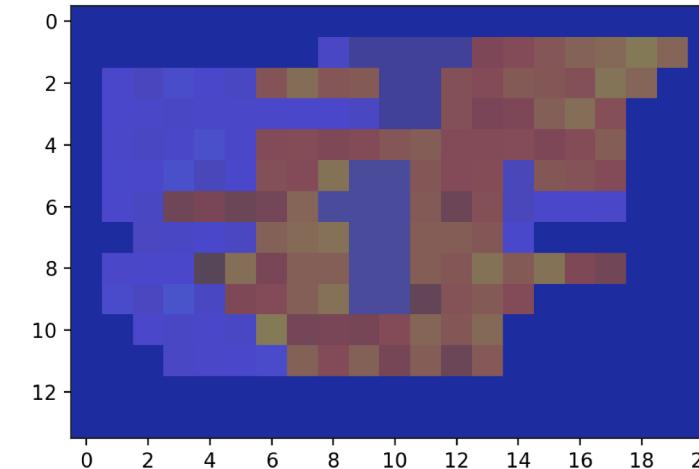


Total number of carnivores: 0



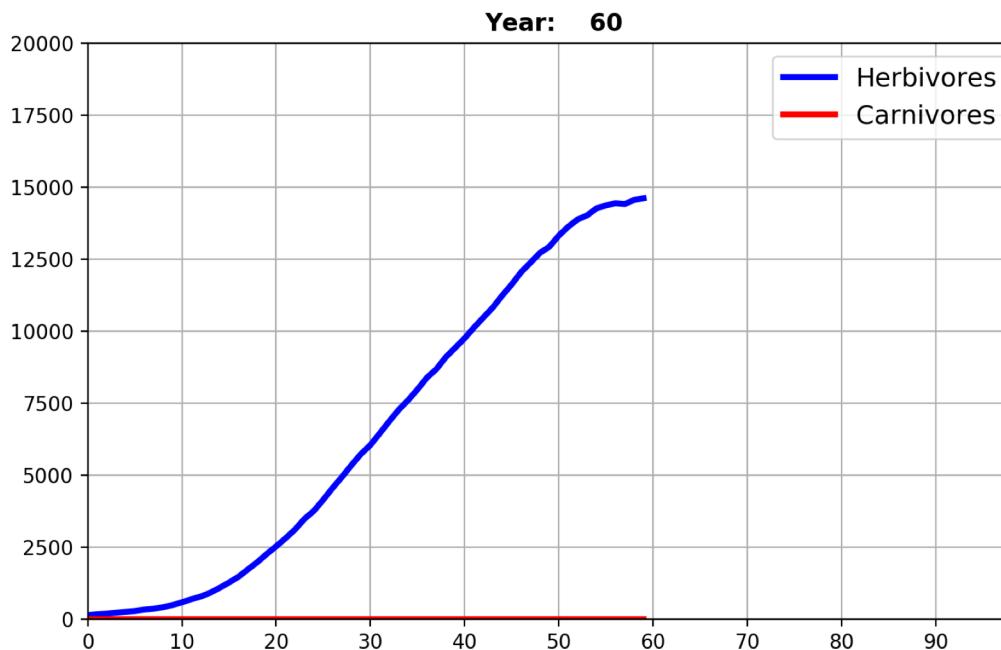


Herbivore distribution



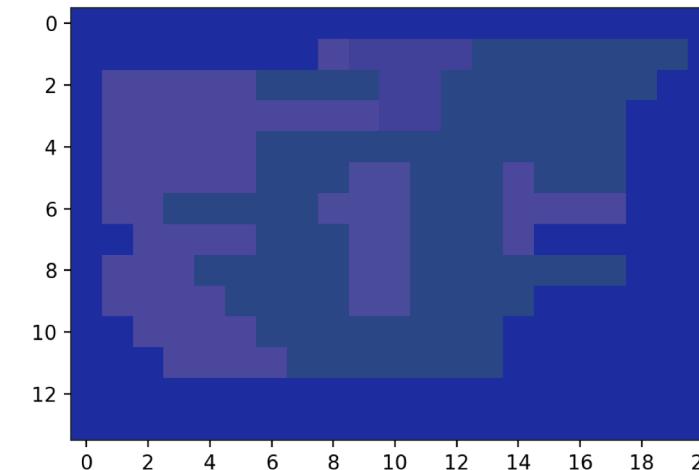
N M B U

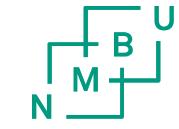
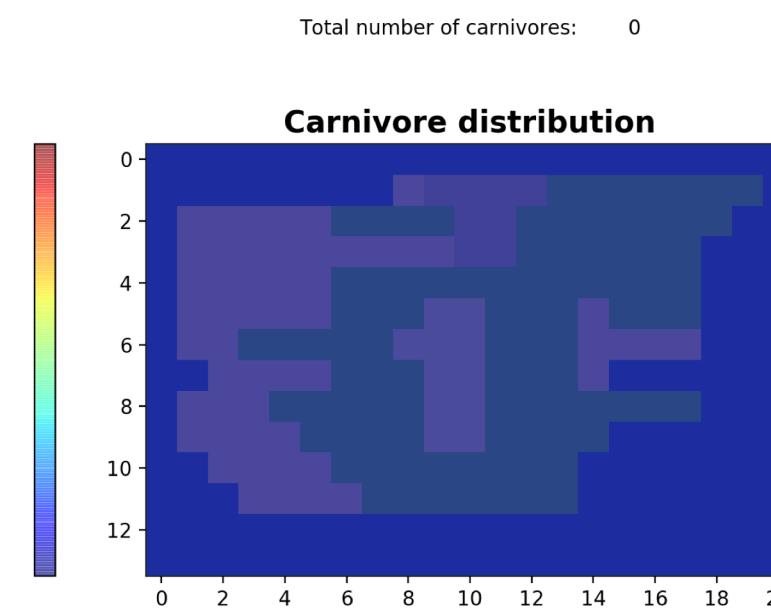
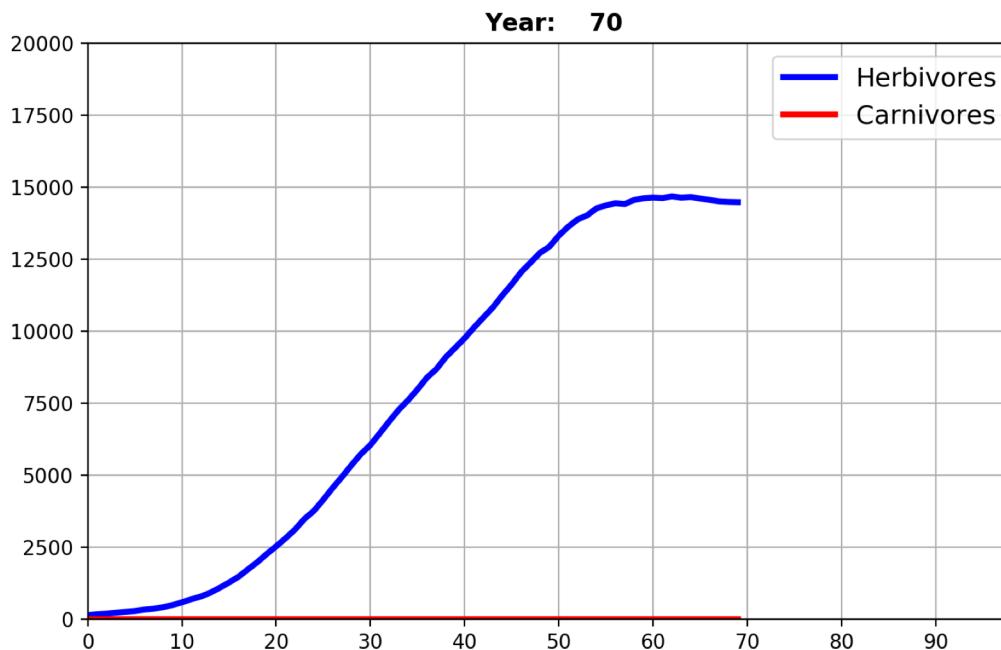
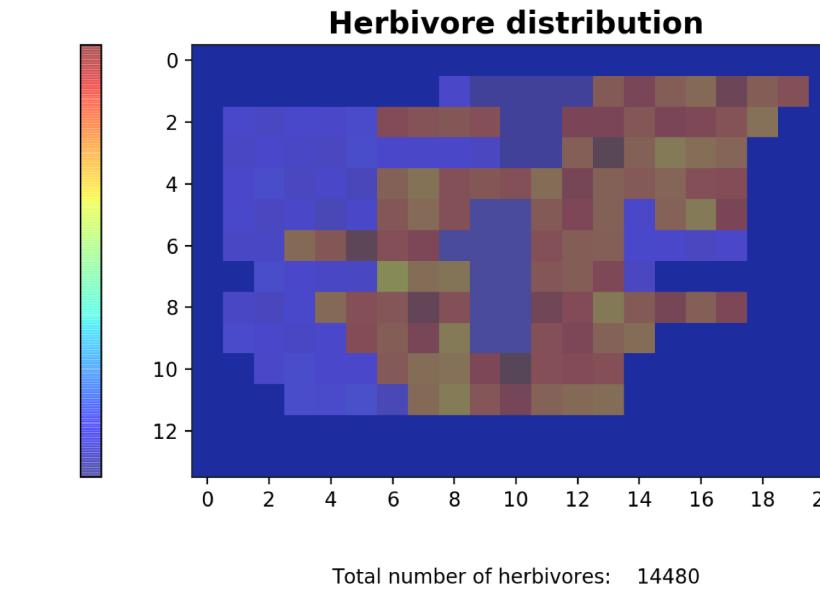
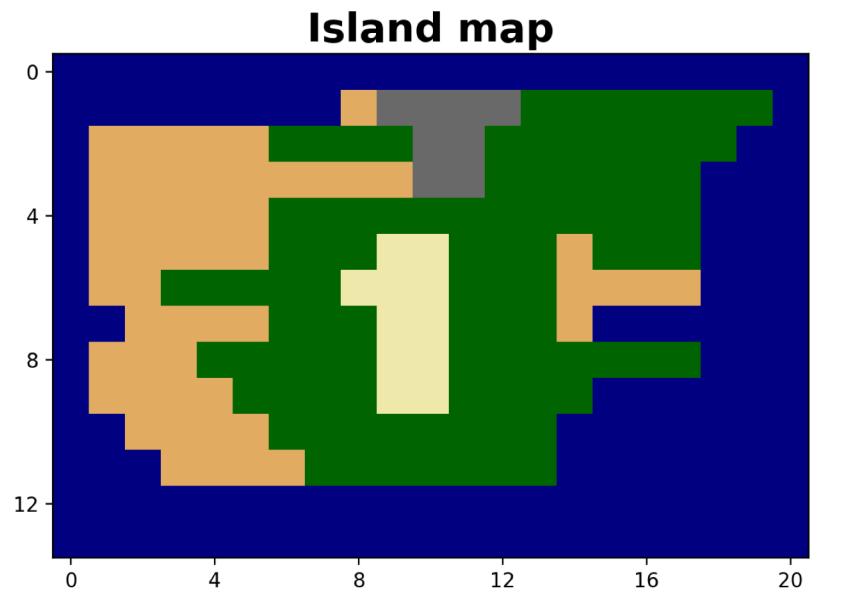
Total number of herbivores: 14617

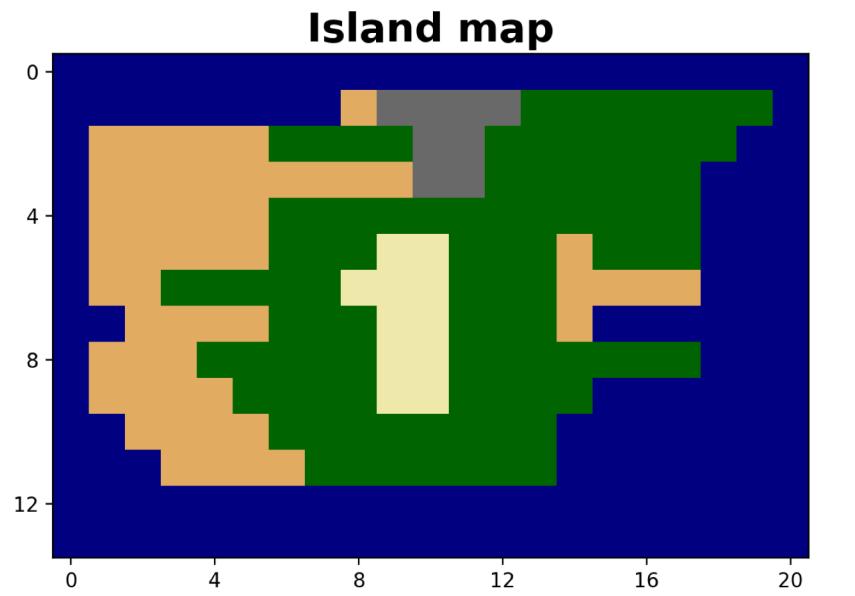


Total number of carnivores: 0

Carnivore distribution

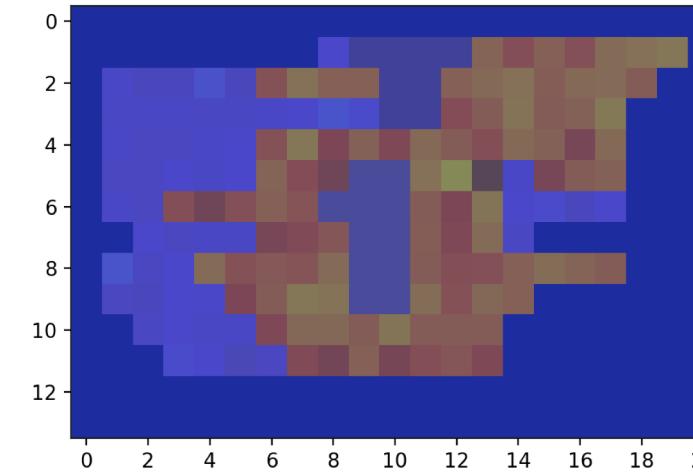




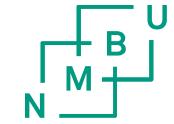


Desert
Savannah
Jungle
Mountain
Ocean

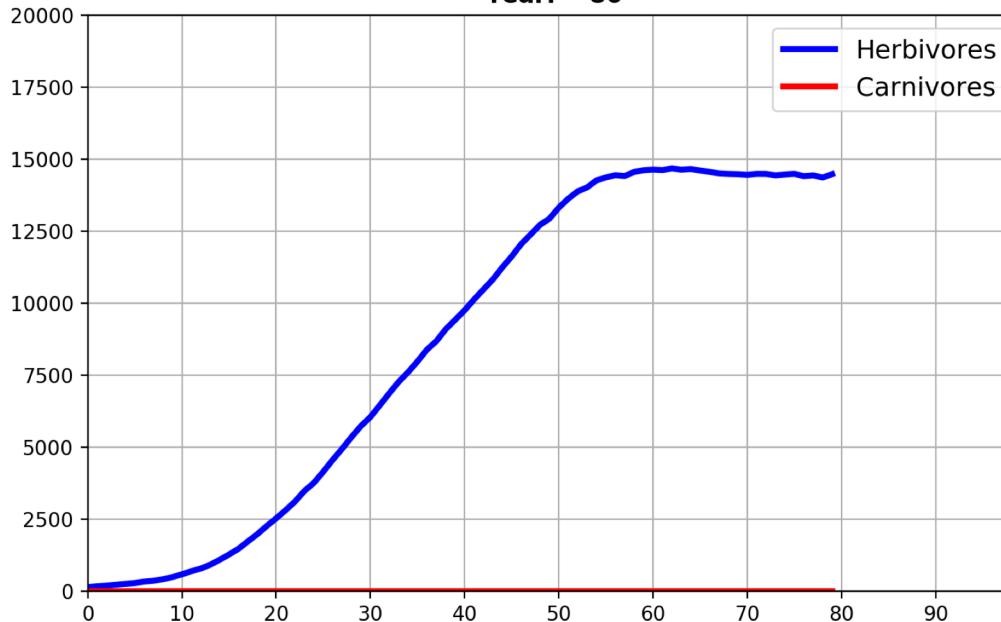
Herbivore distribution



Total number of herbivores: 14480

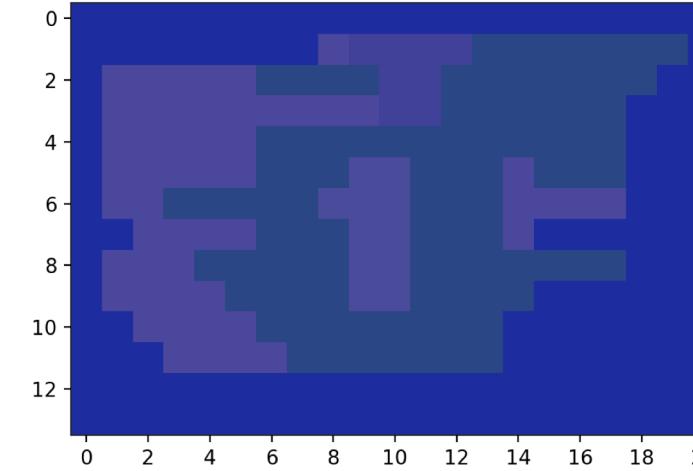


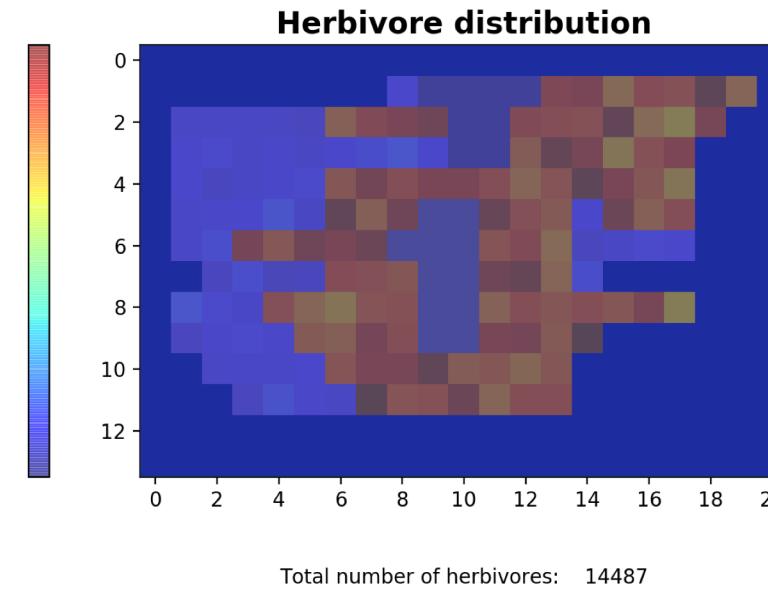
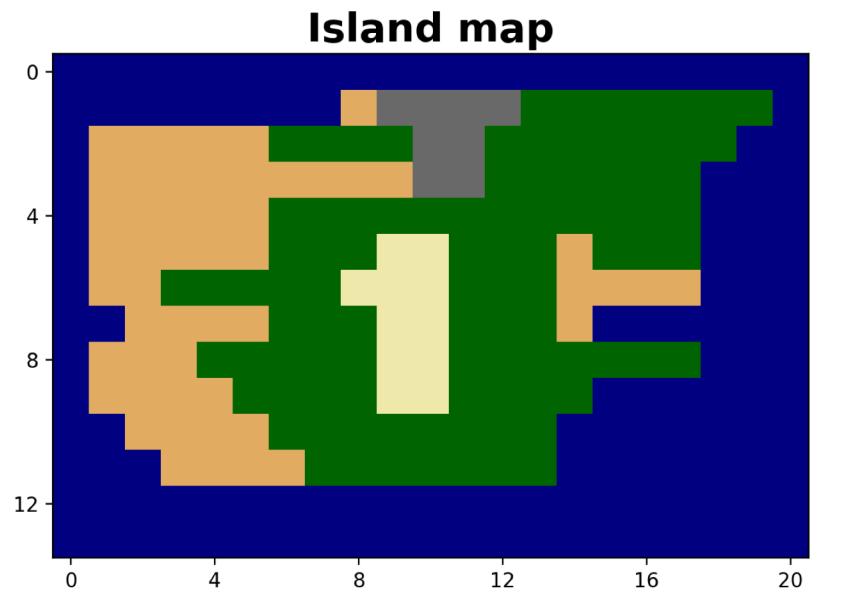
Year: 80



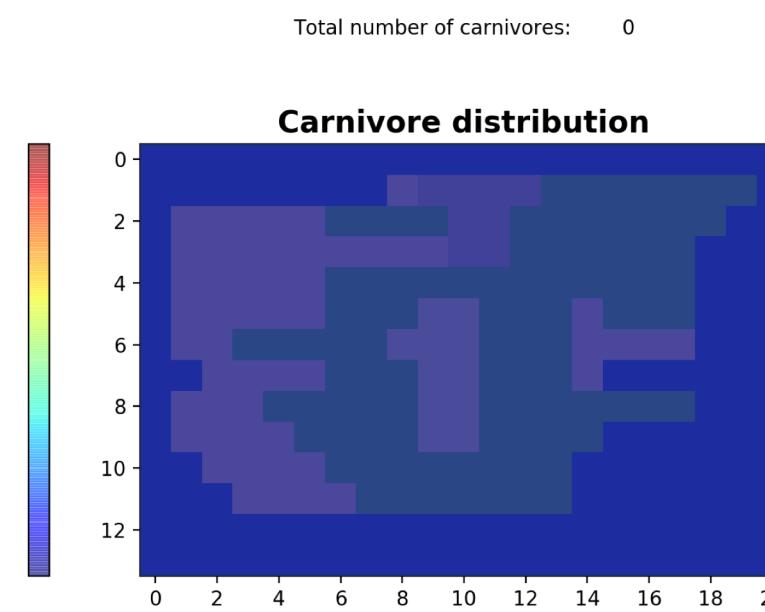
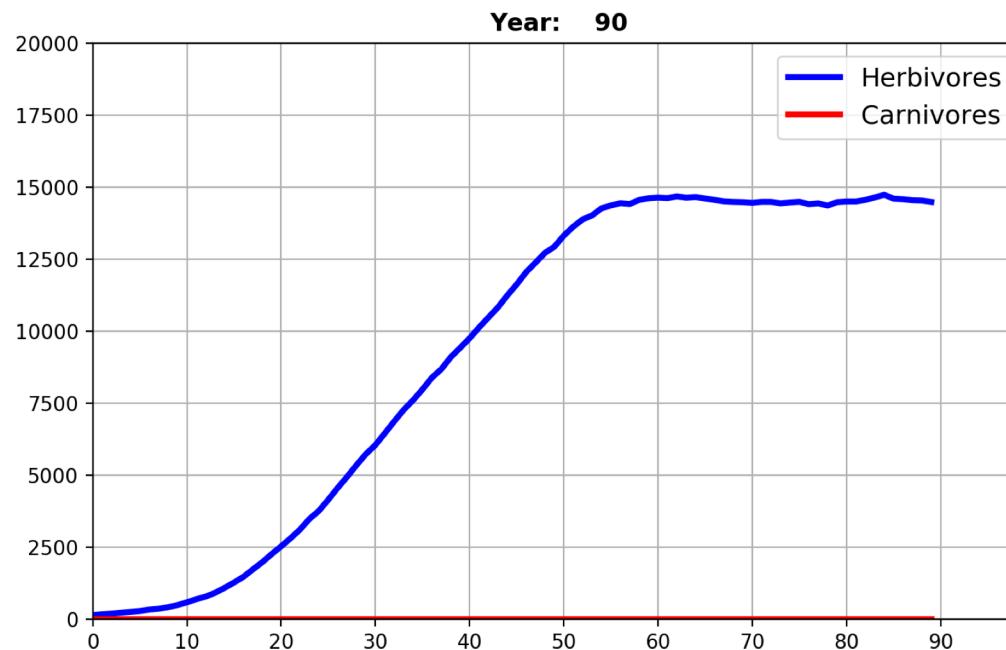
Total number of carnivores: 0

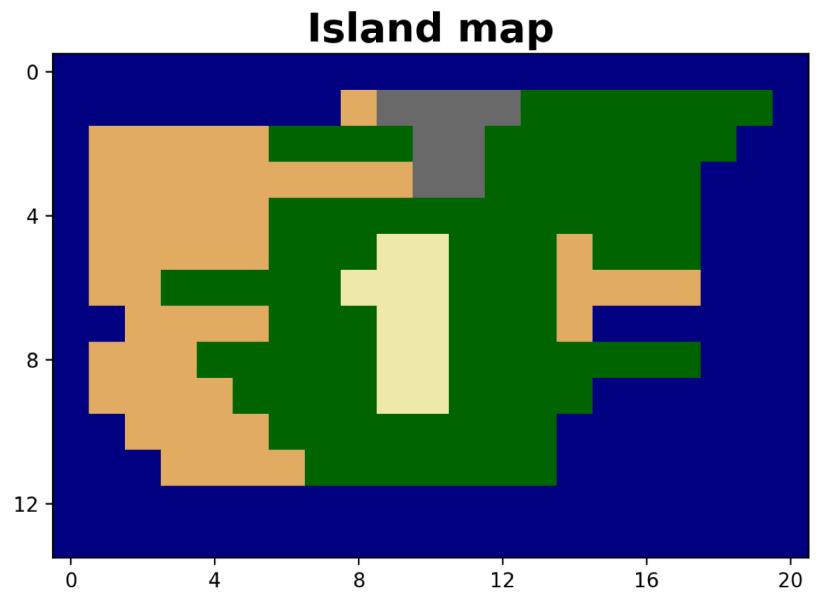
Carnivore distribution



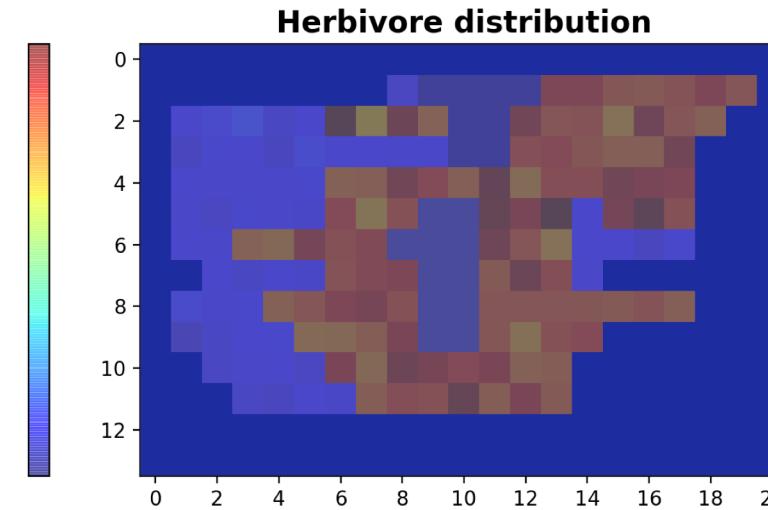


N M B U

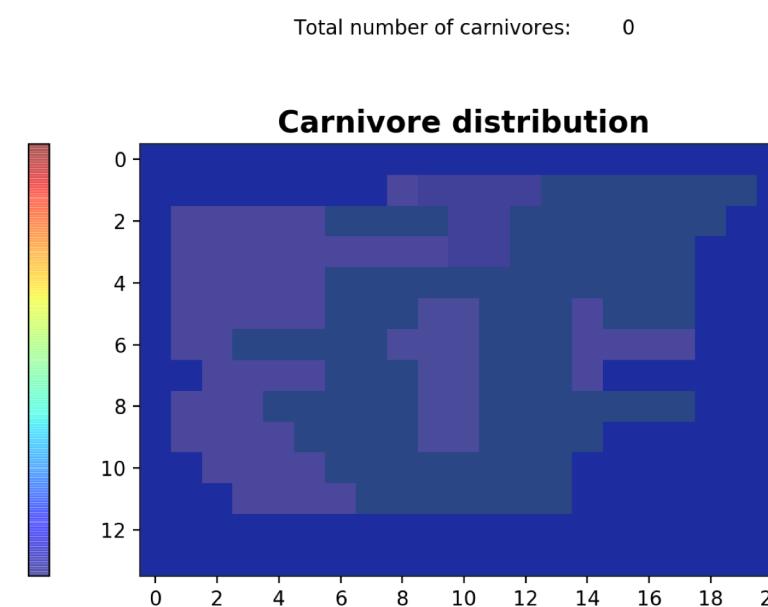
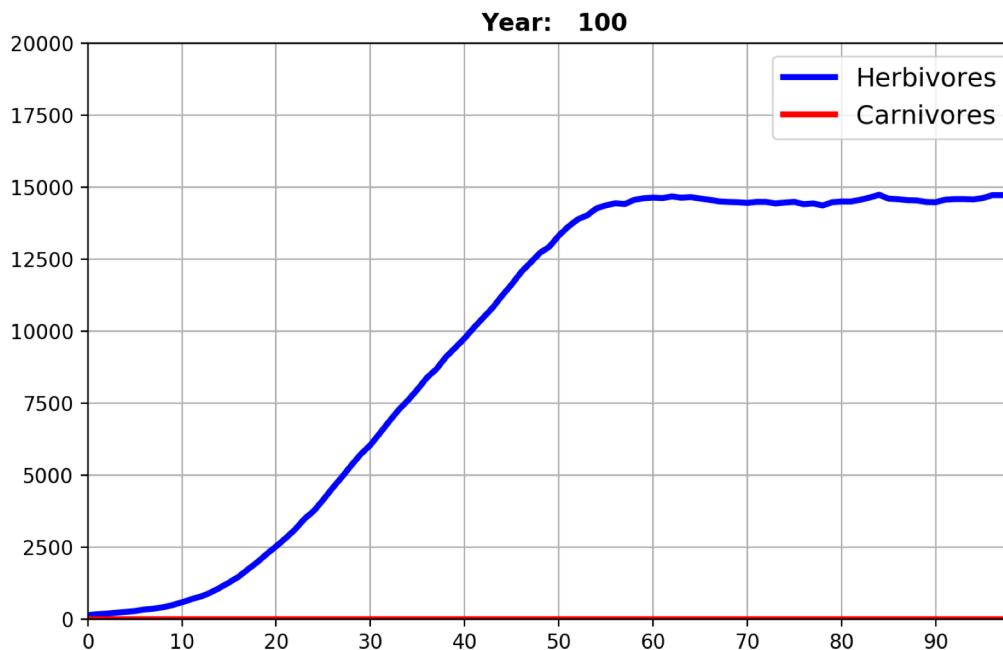
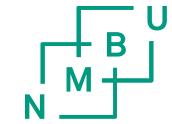




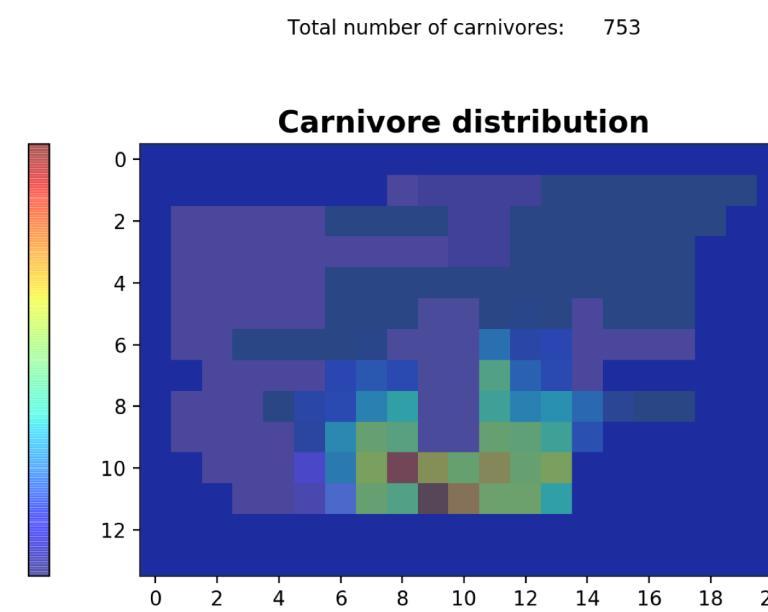
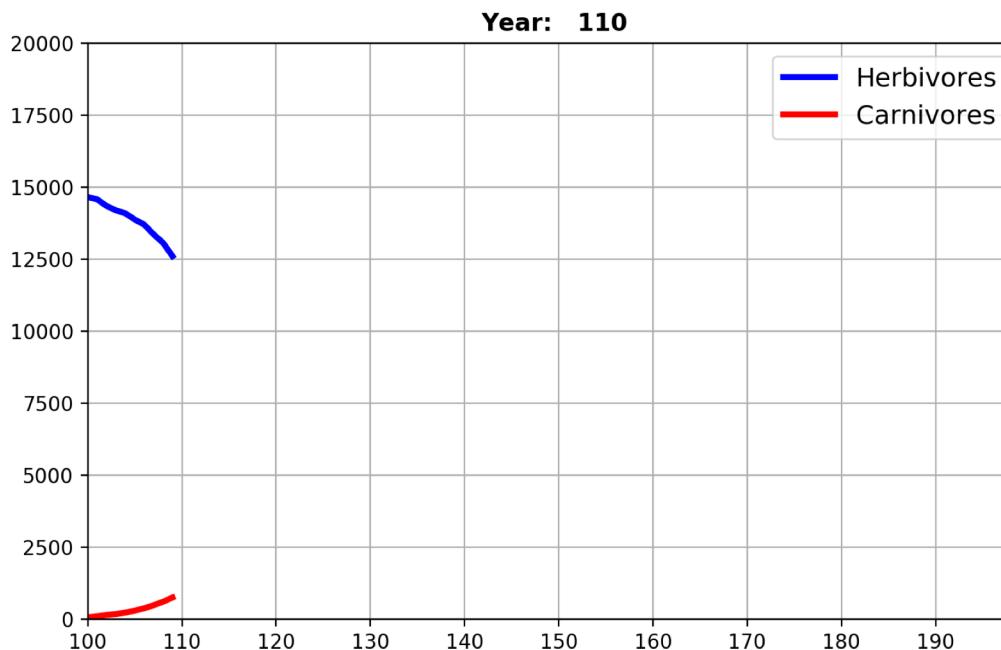
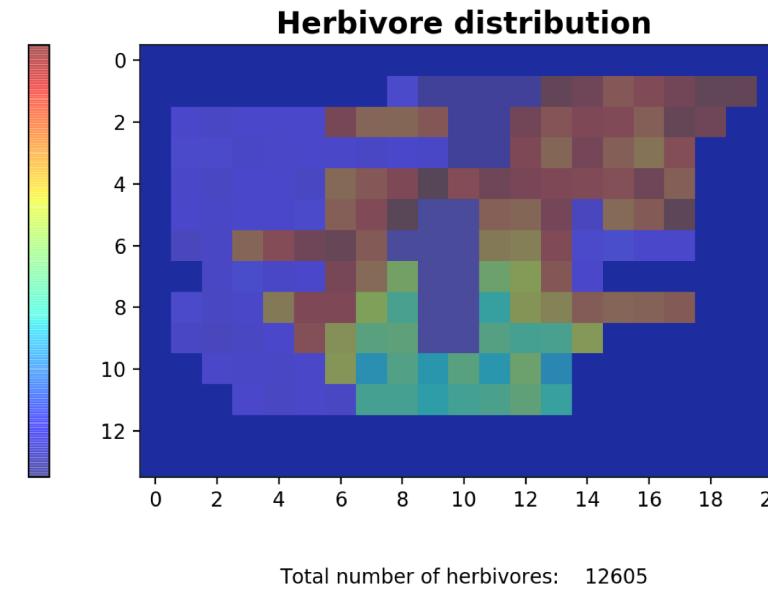
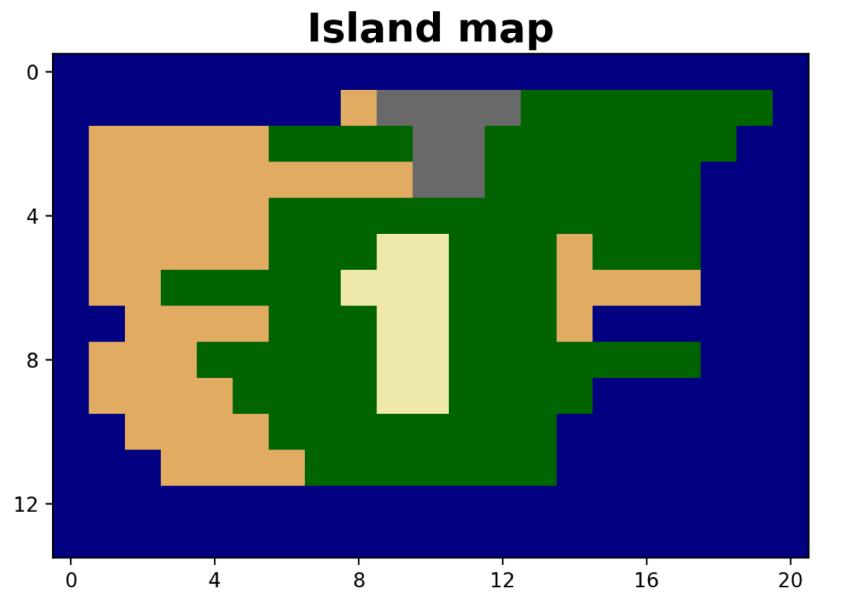
- Desert
- Savannah
- Jungle
- Mountain
- Ocean

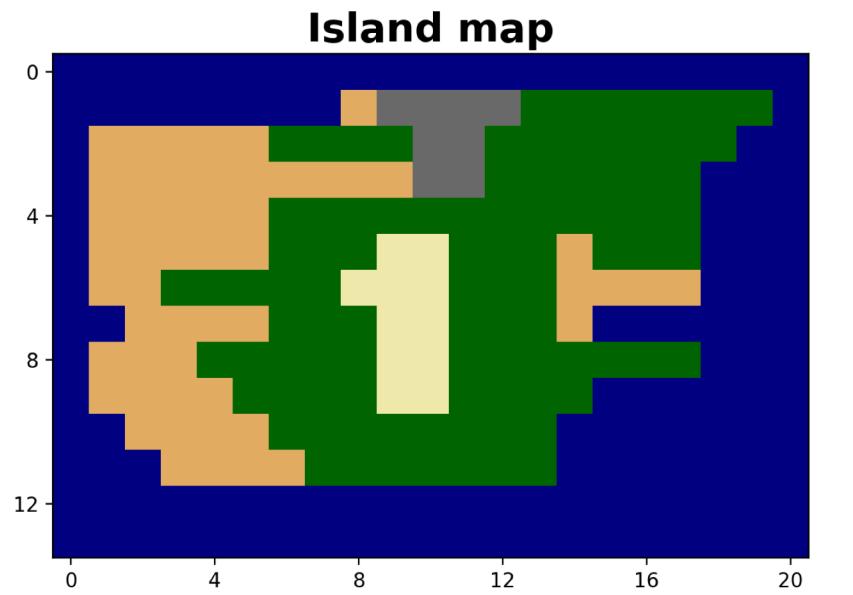


Total number of herbivores: 14719



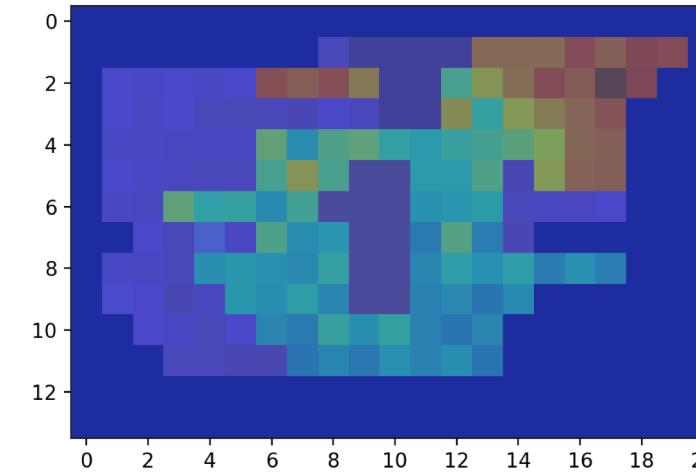
Total number of carnivores: 0



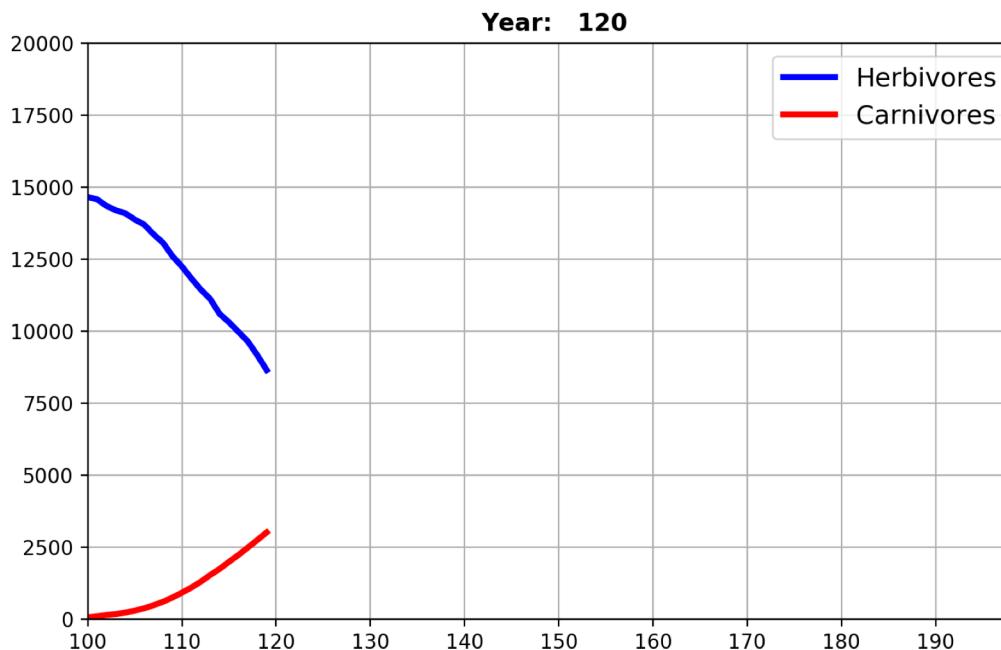


Desert
Savannah
Jungle
Mountain
Ocean

Herbivore distribution

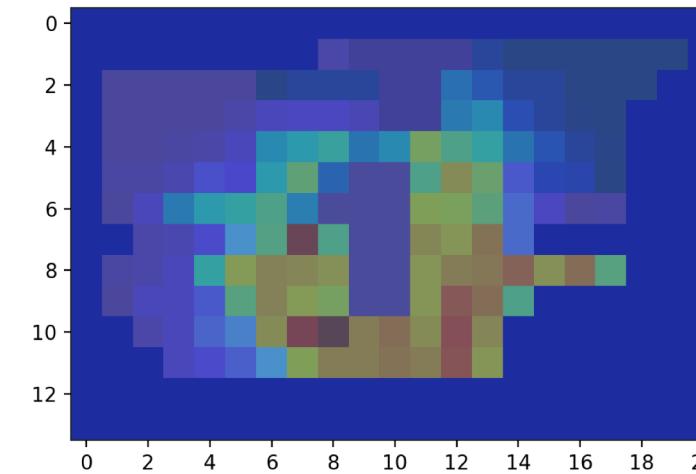


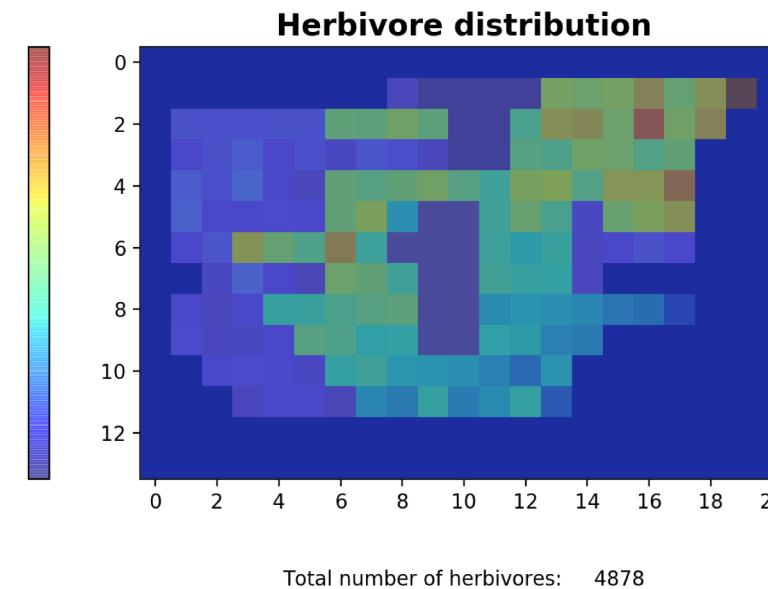
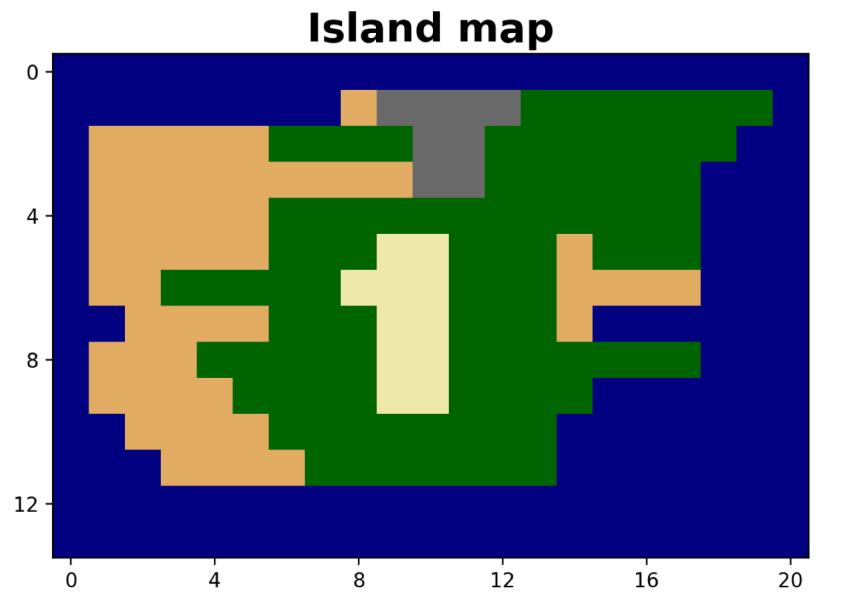
Total number of herbivores: 8649



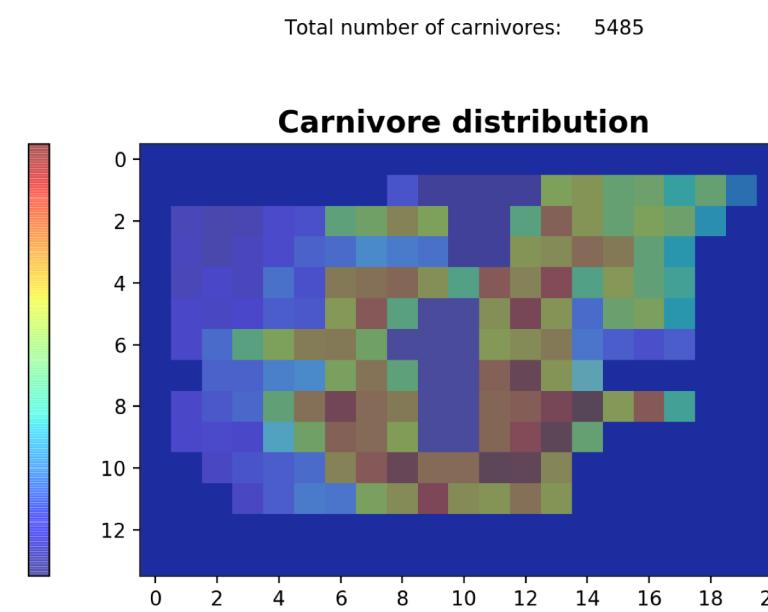
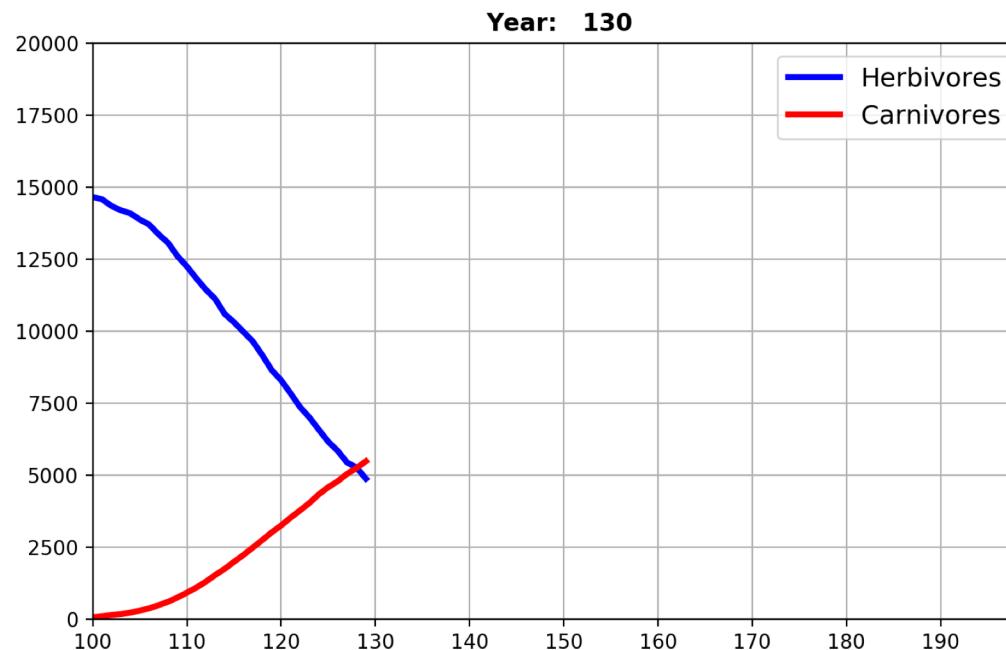
Total number of carnivores: 3016

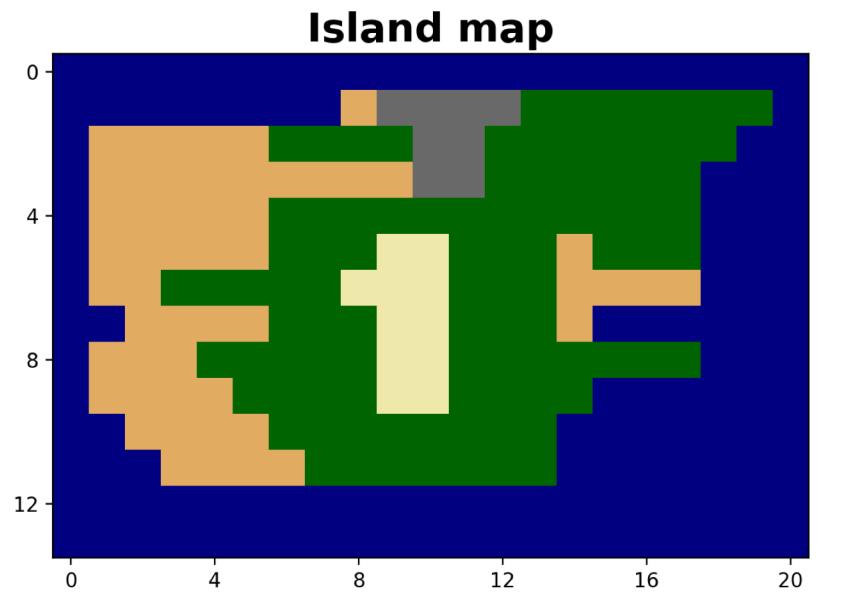
Carnivore distribution



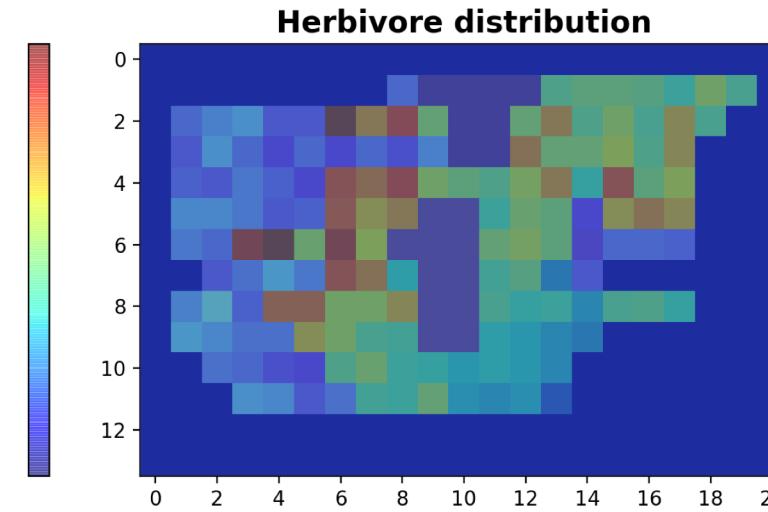


N M B U

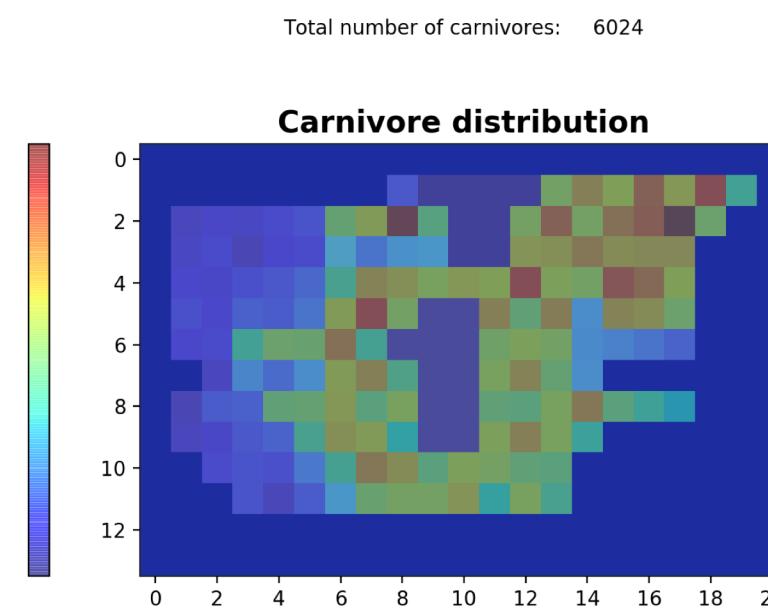
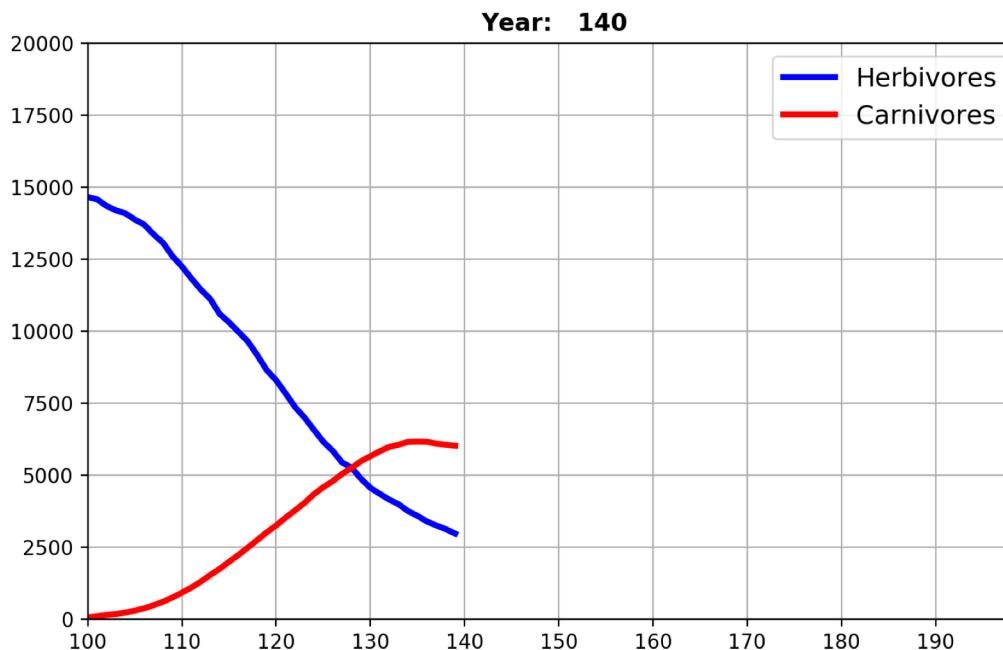


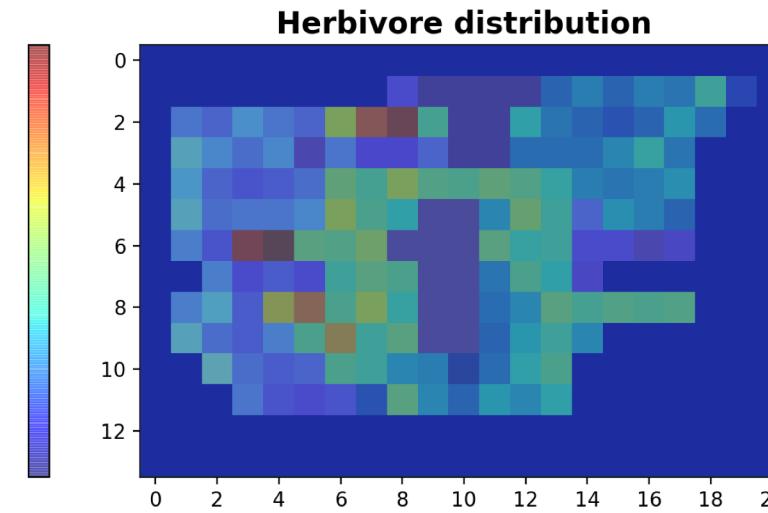
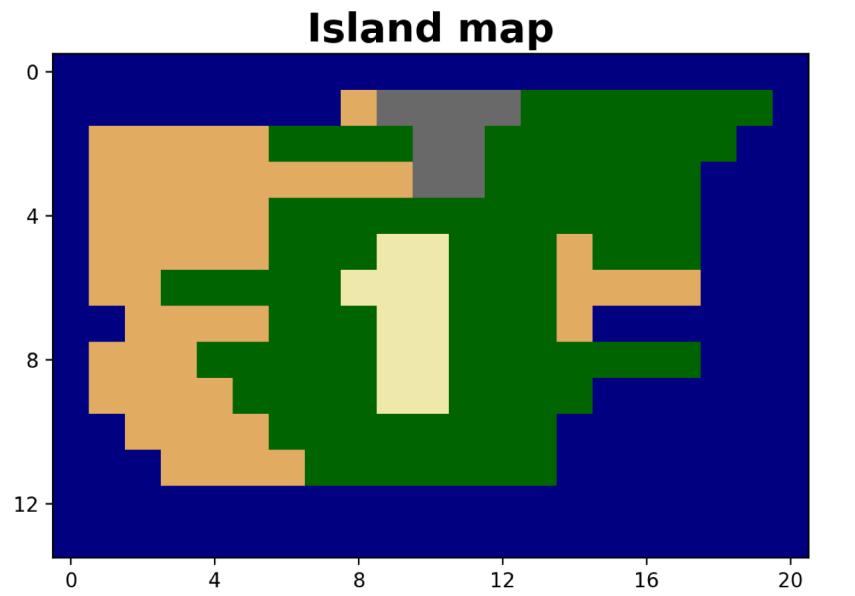


Desert
Savannah
Jungle
Mountain
Ocean

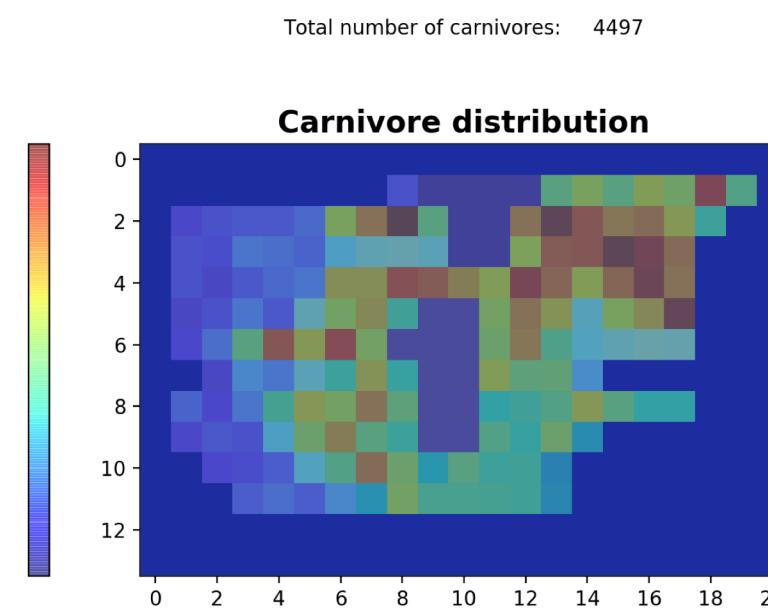
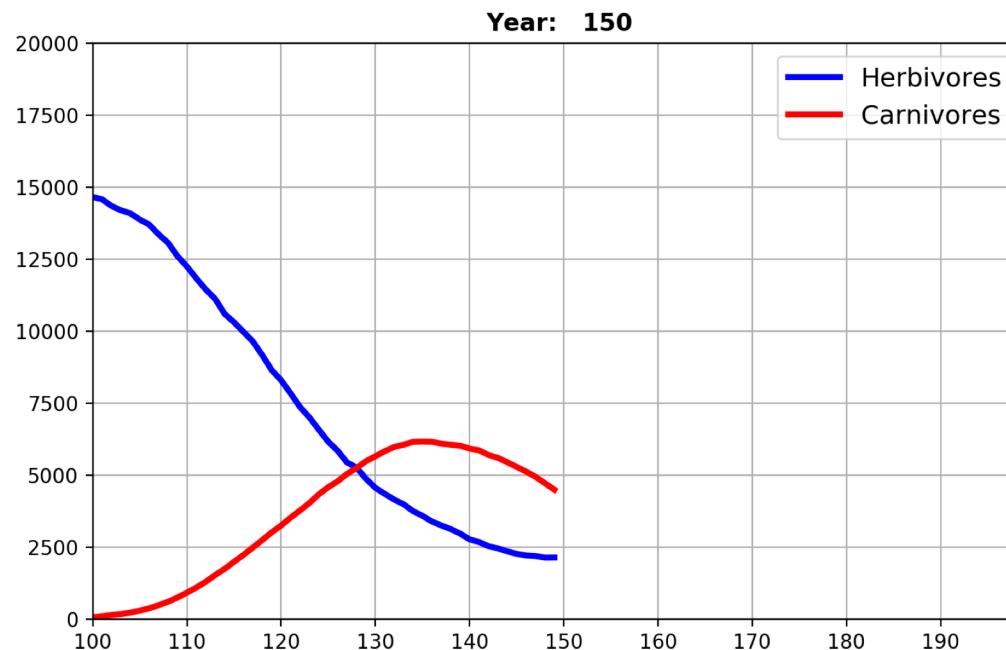


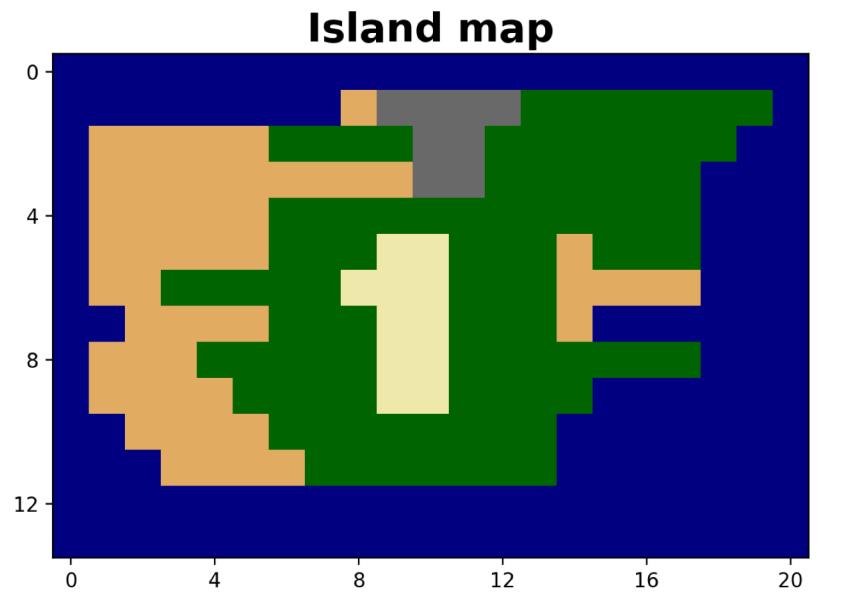
N M B U





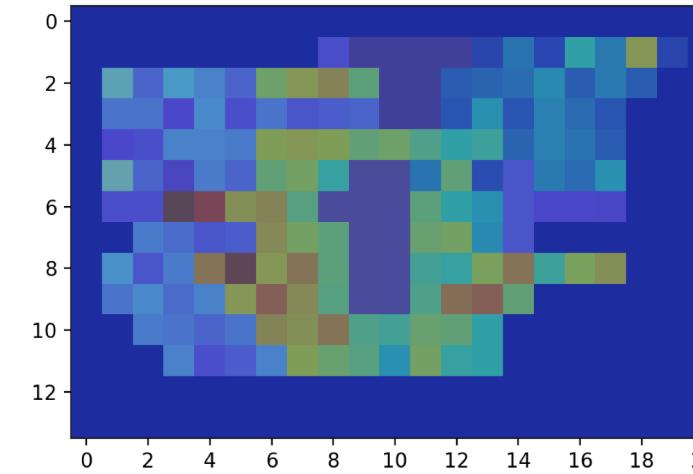
N M B U



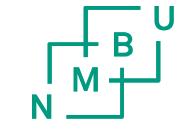


Desert
Savannah
Jungle
Mountain
Ocean

Herbivore distribution

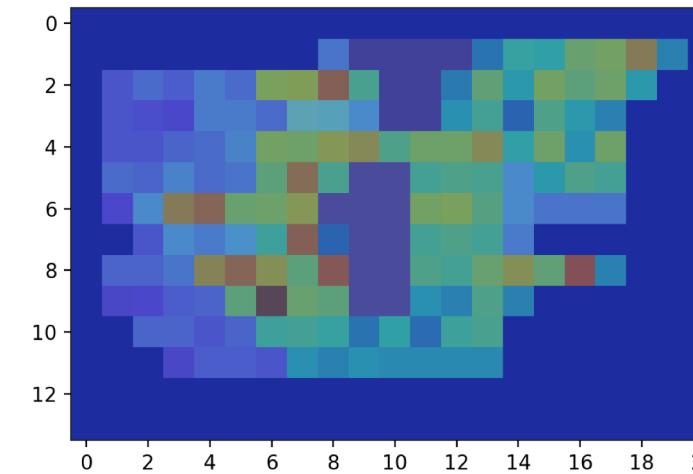


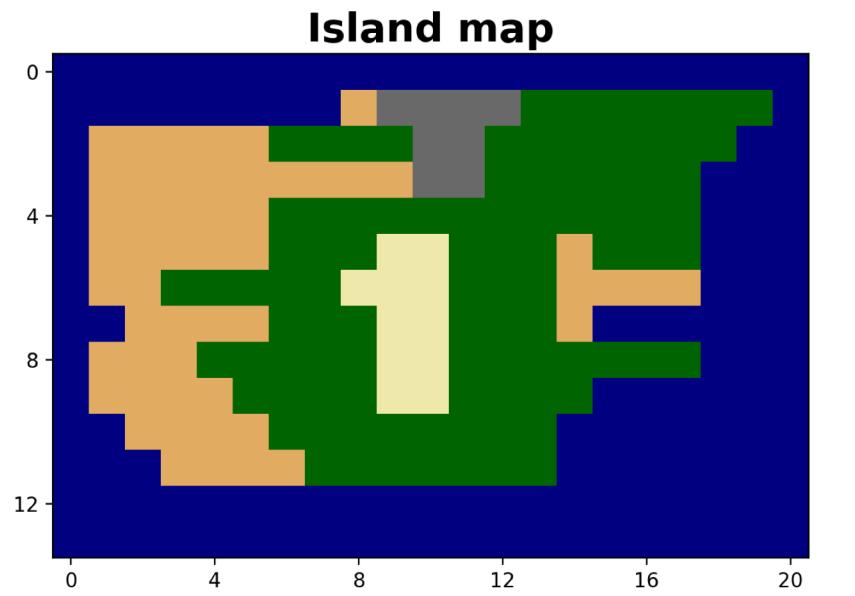
Total number of herbivores: 2733



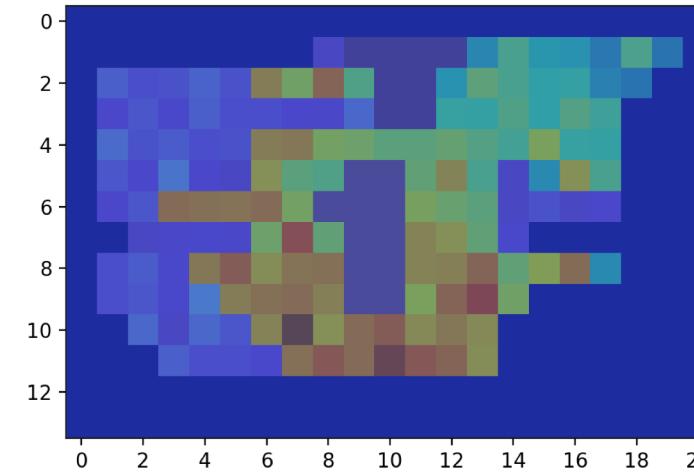
Total number of carnivores: 2820

Carnivore distribution

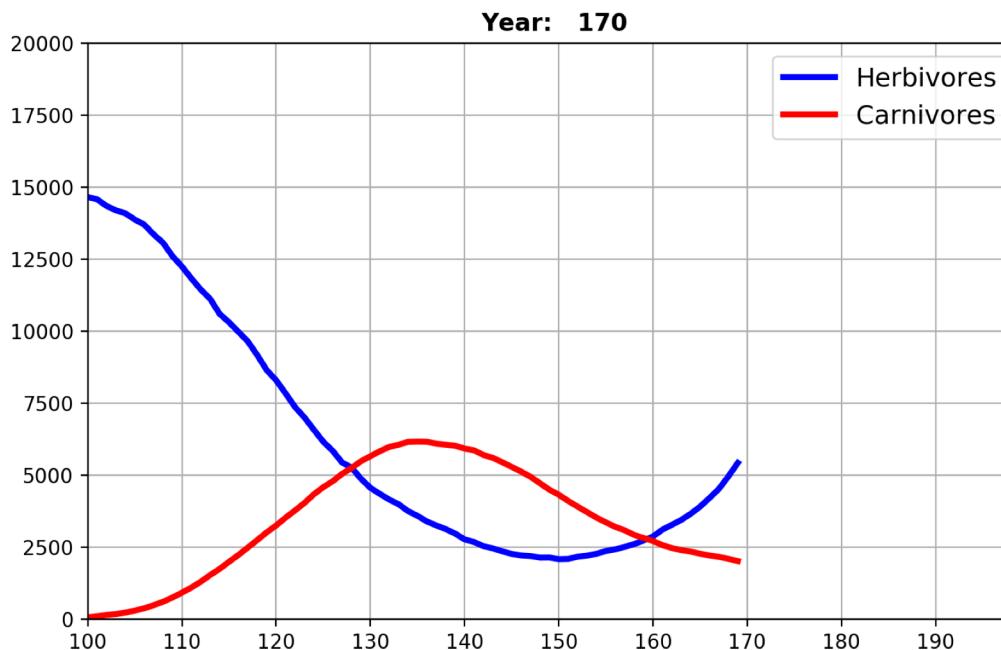




Herbivore distribution

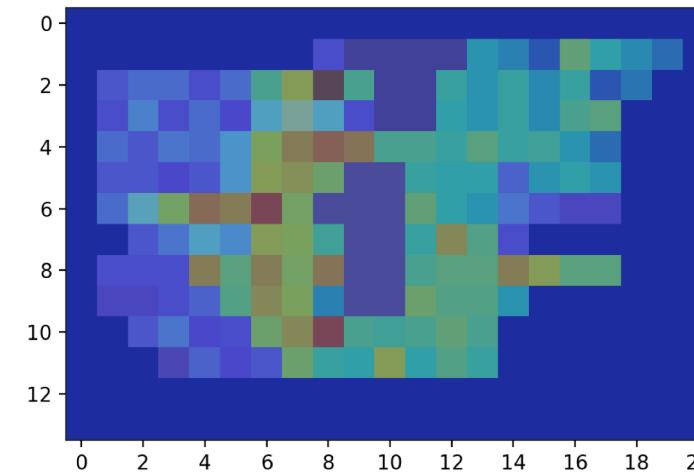


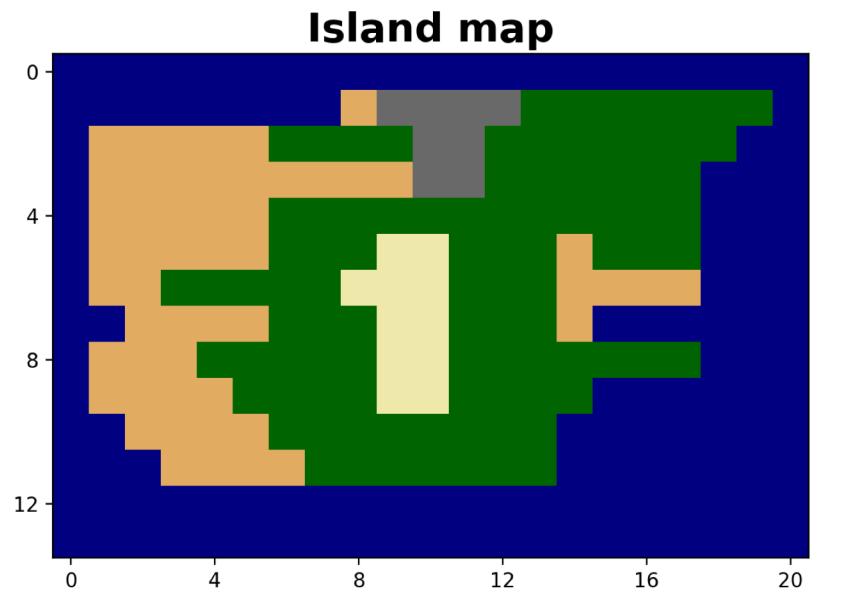
N M B U



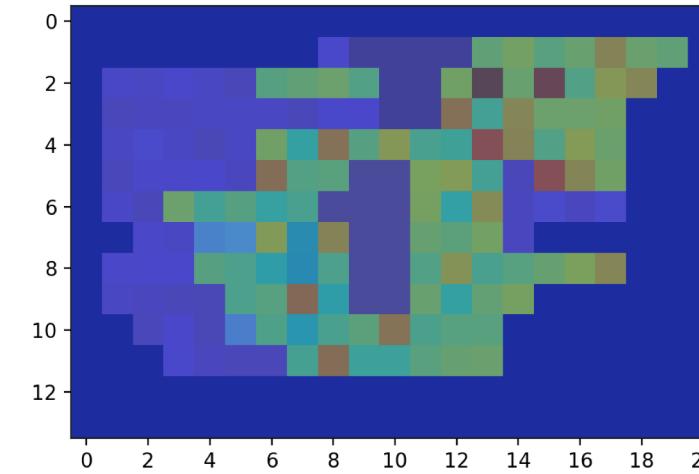
Total number of carnivores: 2018

Carnivore distribution

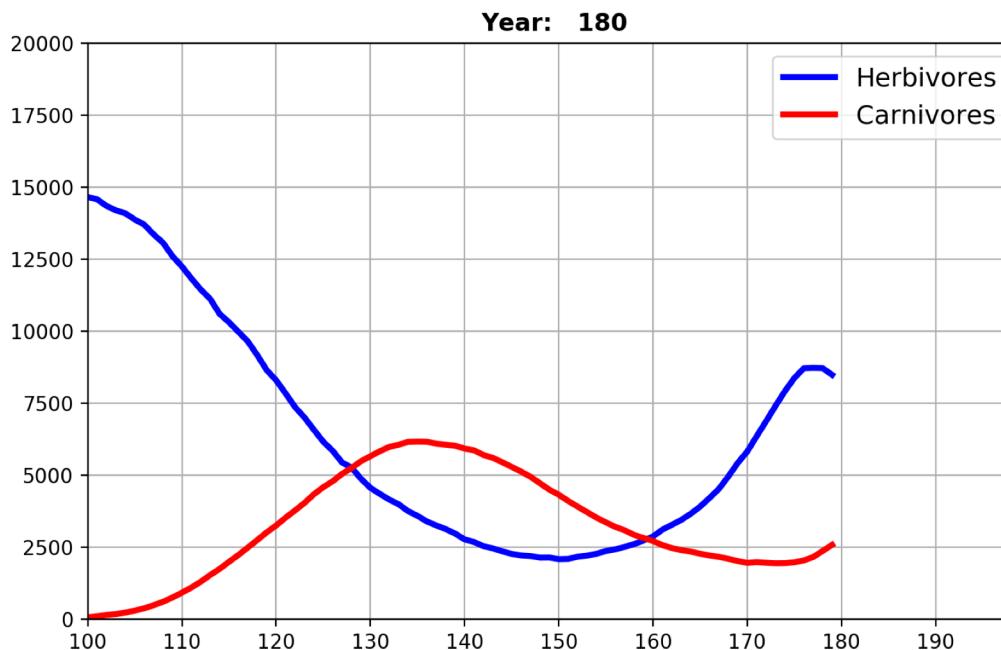




Herbivore distribution

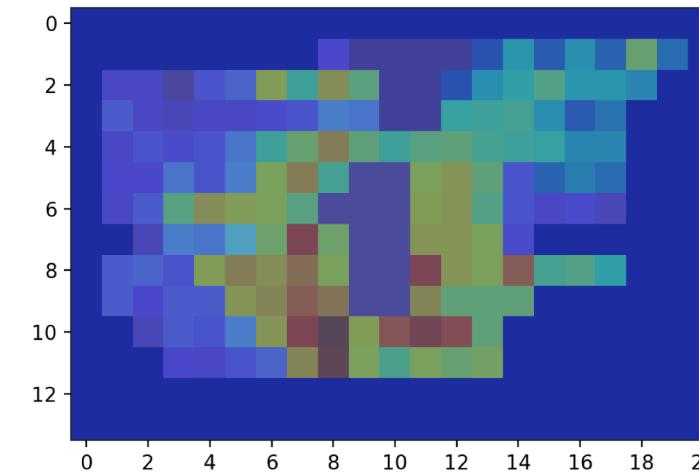


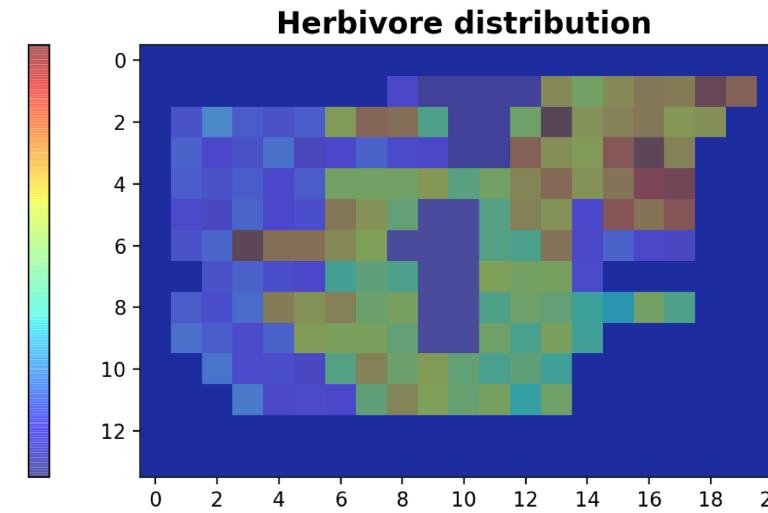
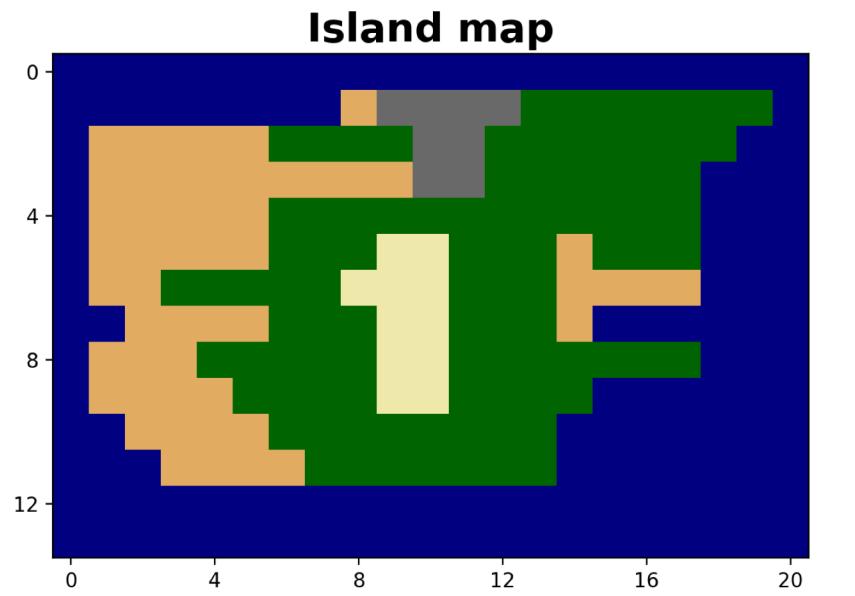
N M B U



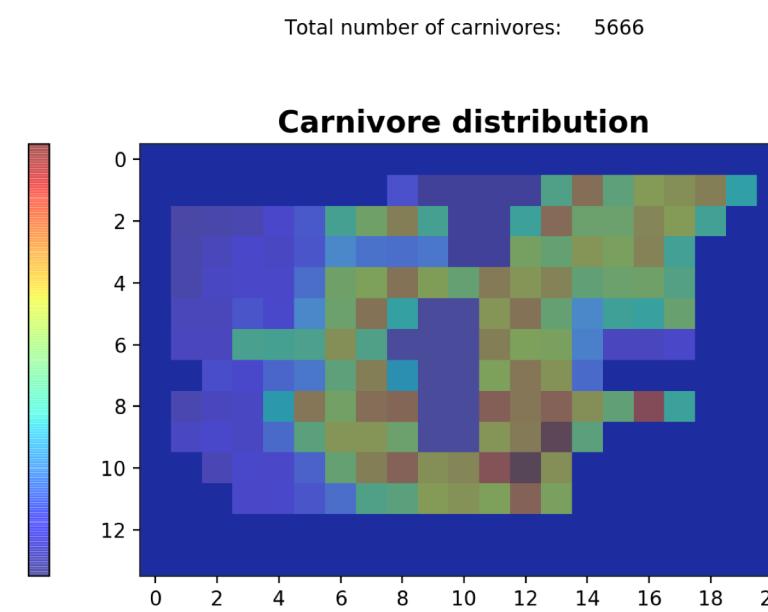
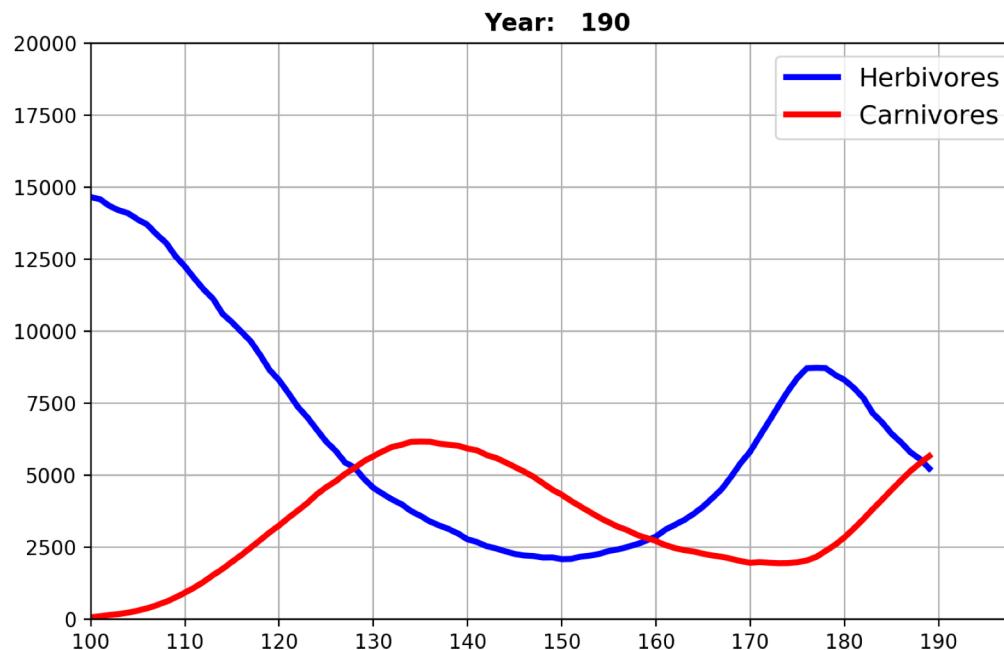
Total number of carnivores: 2581

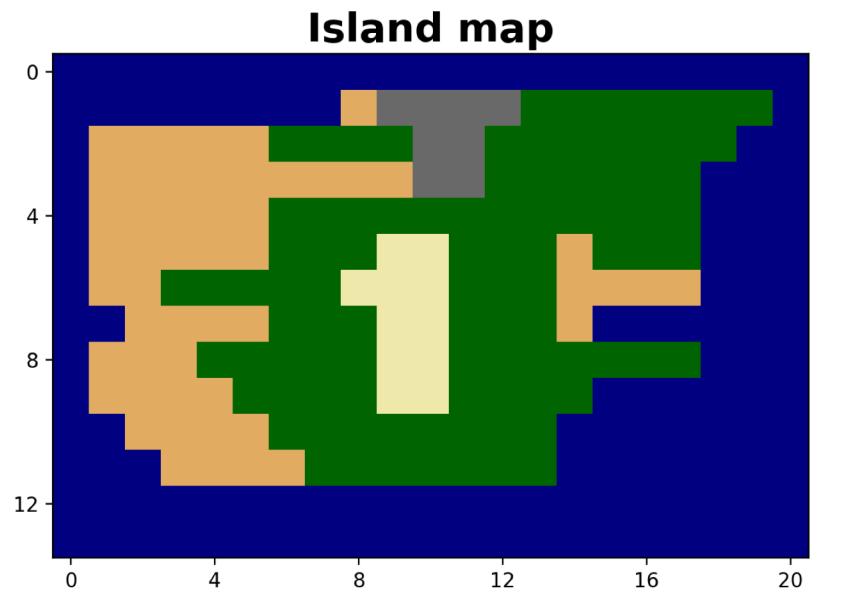
Carnivore distribution



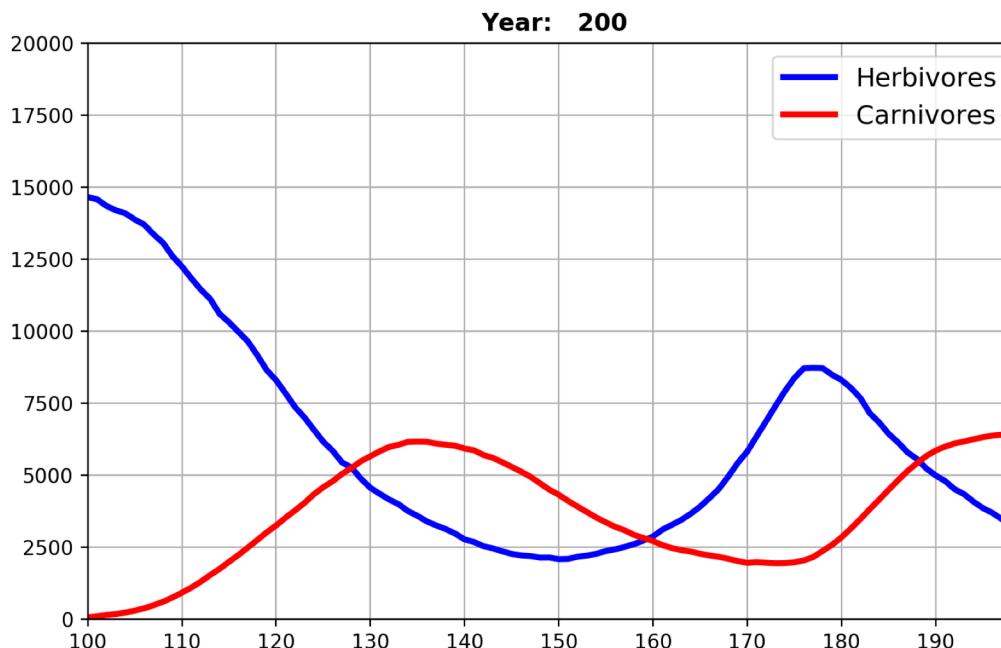
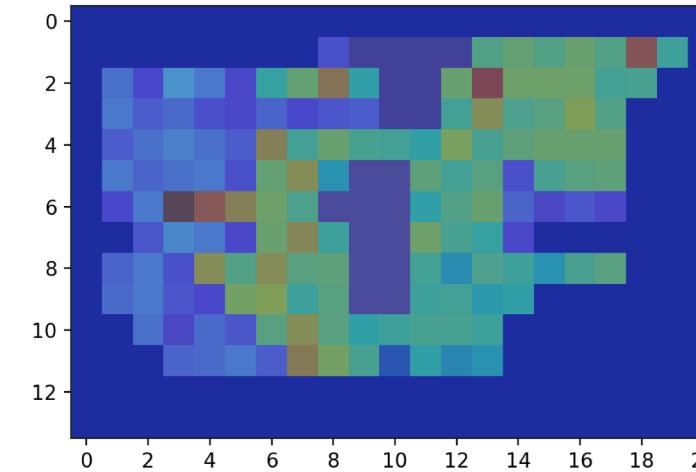


N M B U



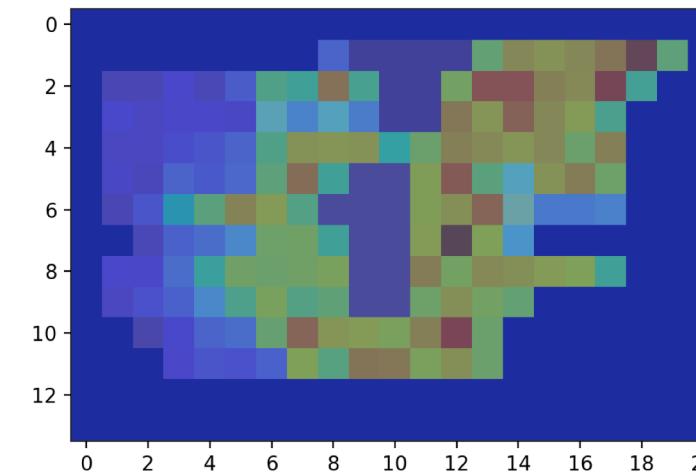


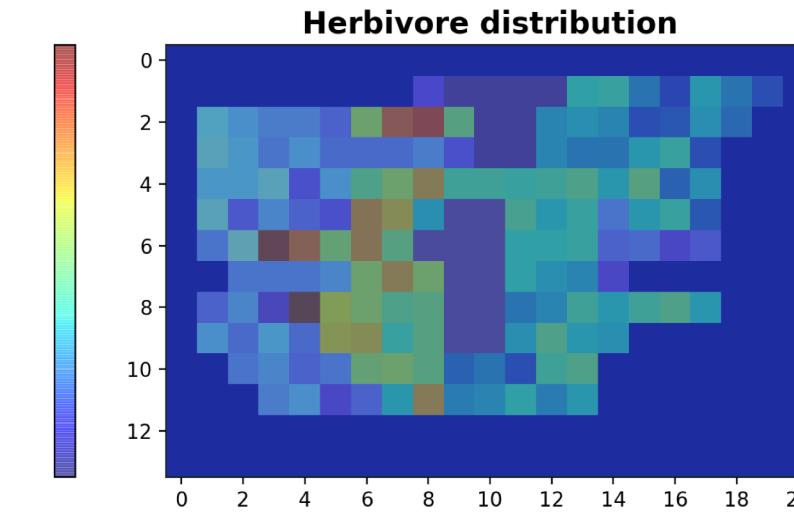
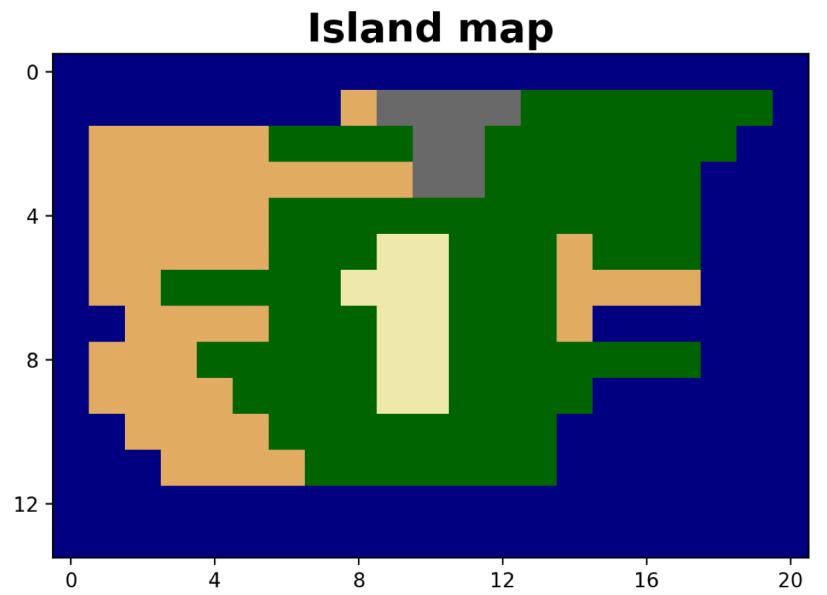
Herbivore distribution



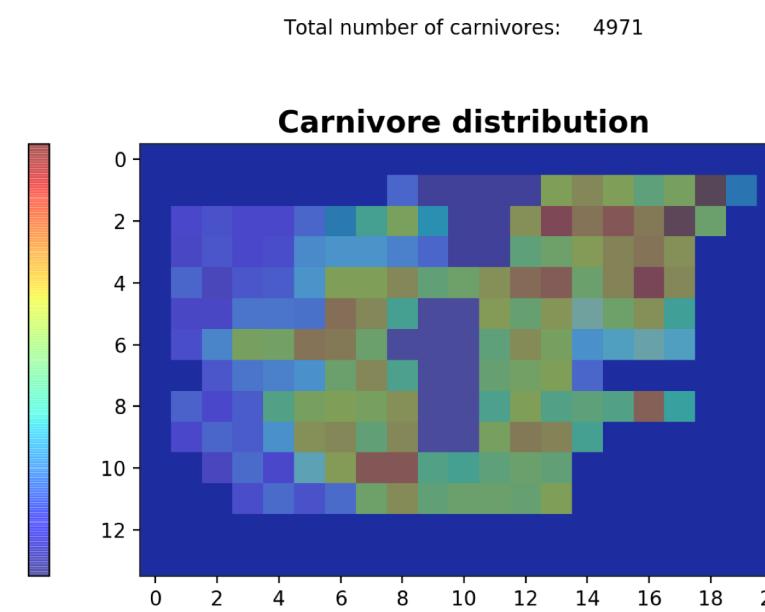
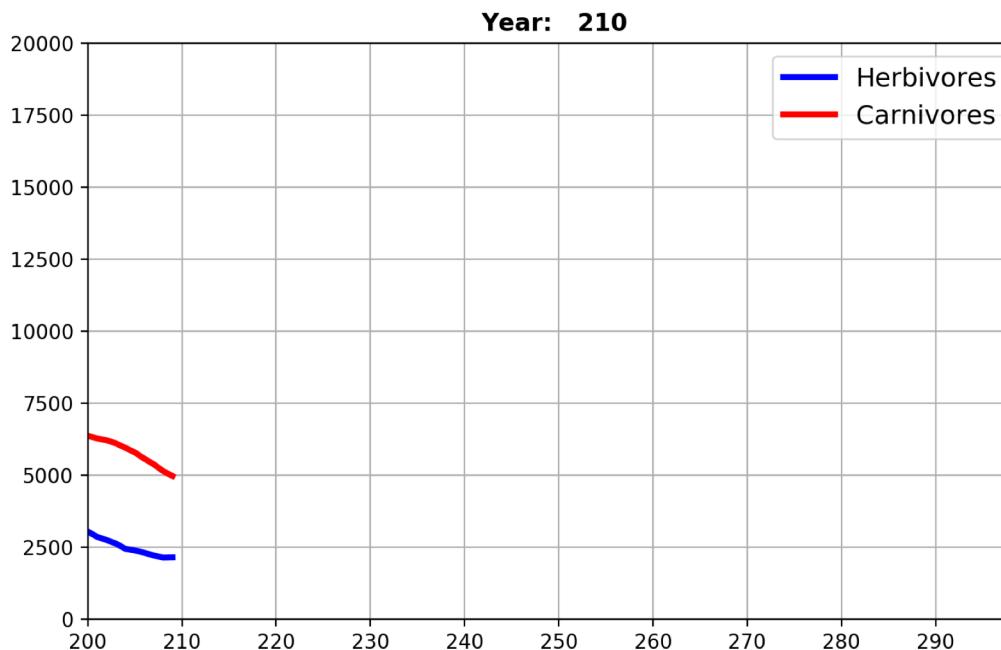
Total number of carnivores: 6363

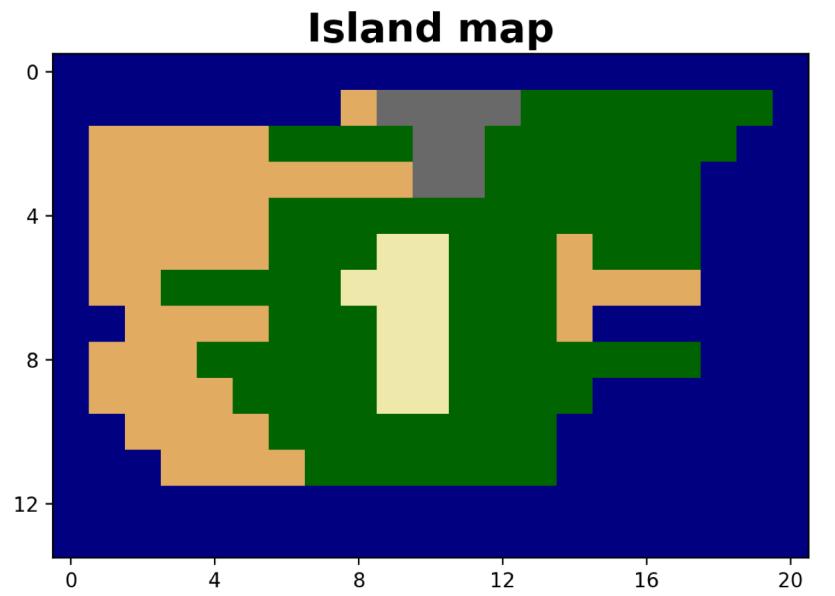
Carnivore distribution



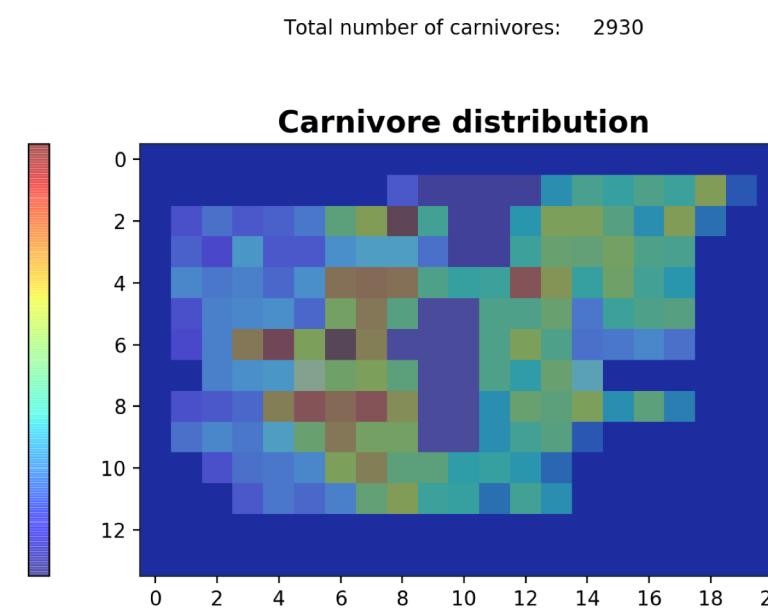
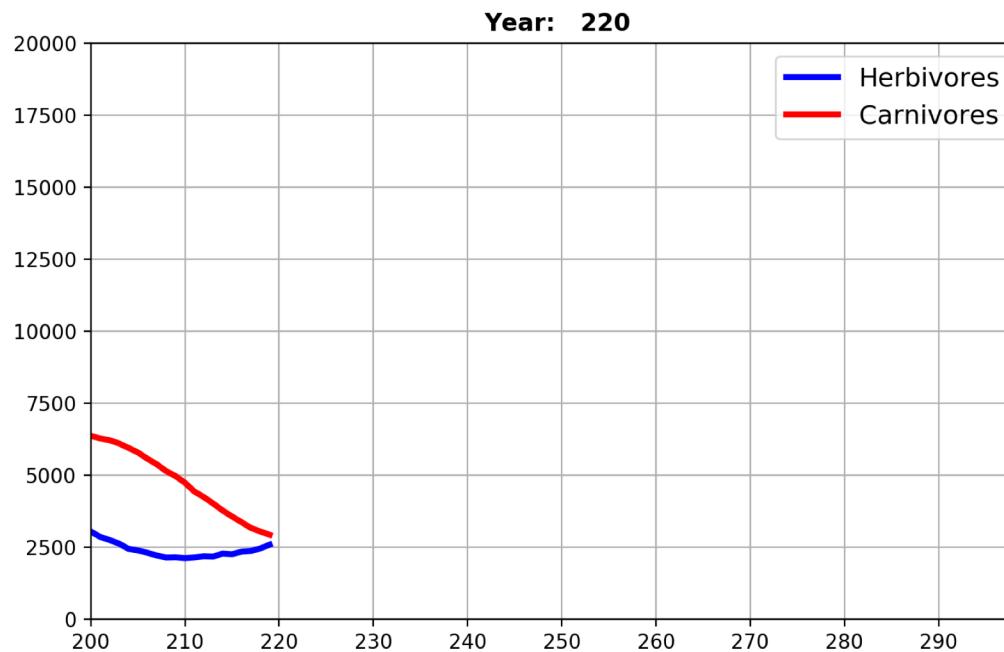
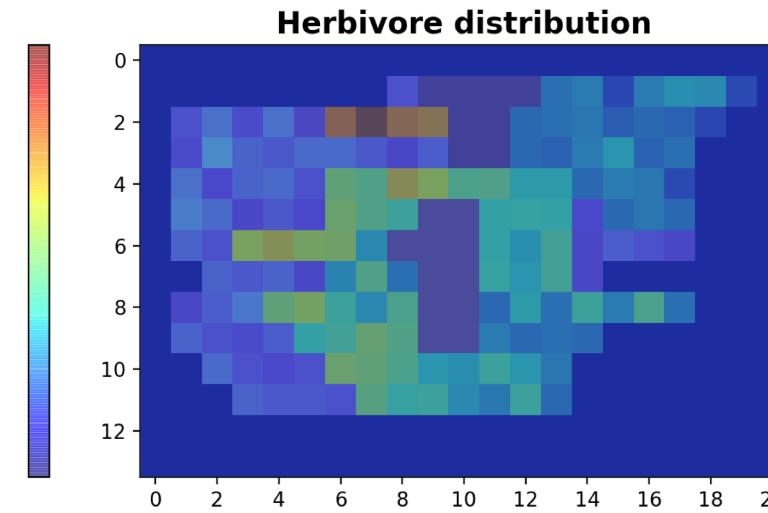


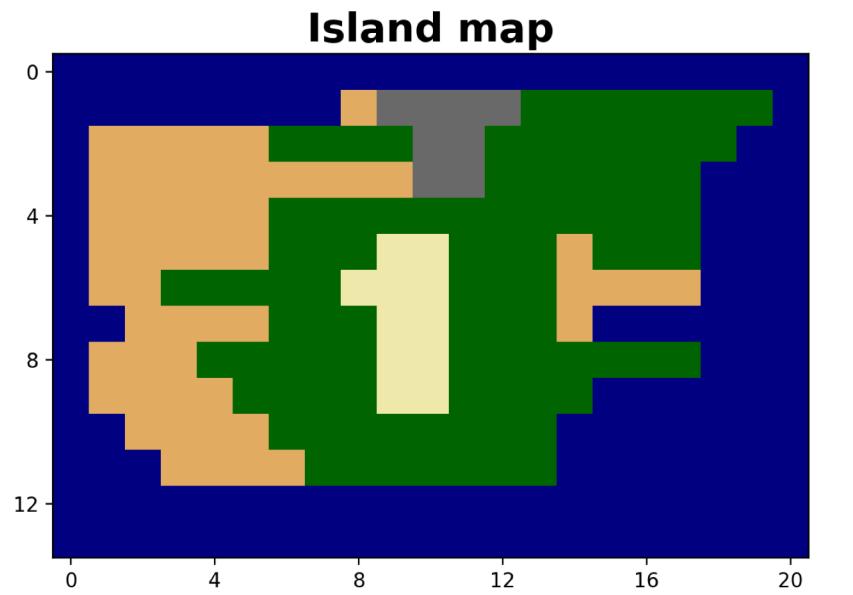
N M B U



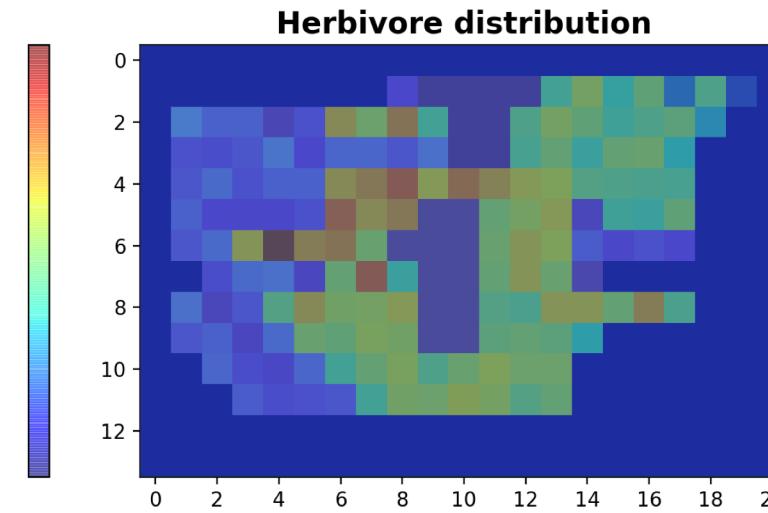


N M B U

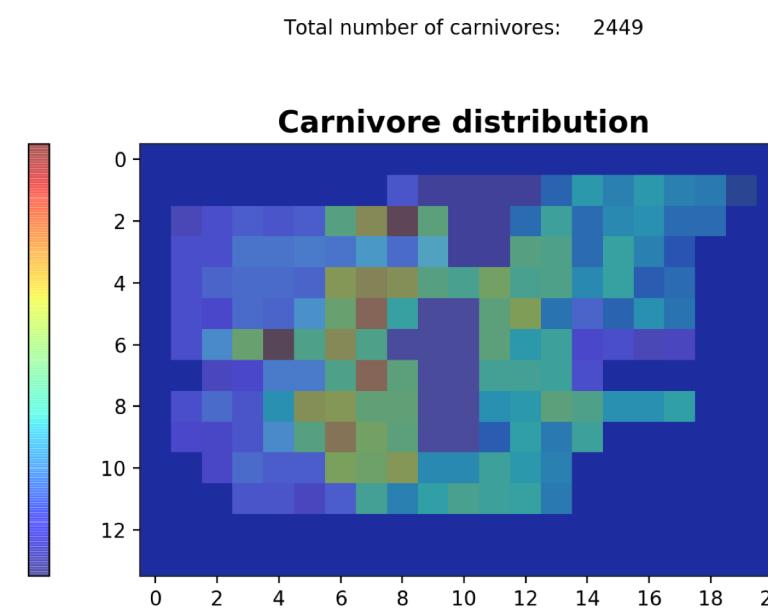
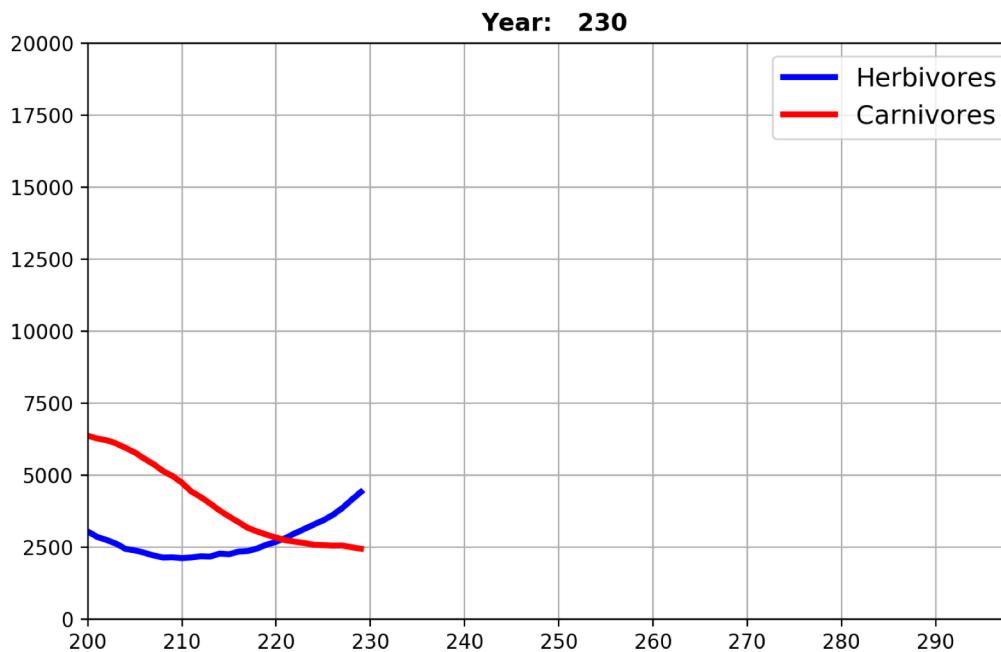




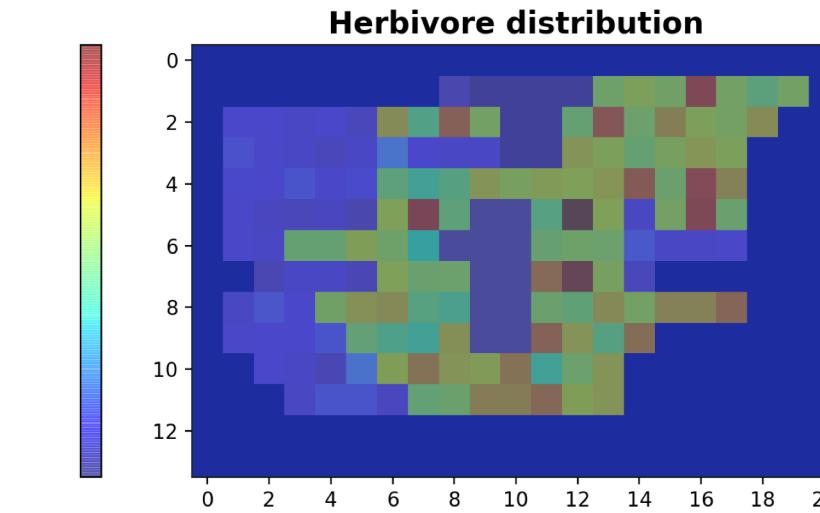
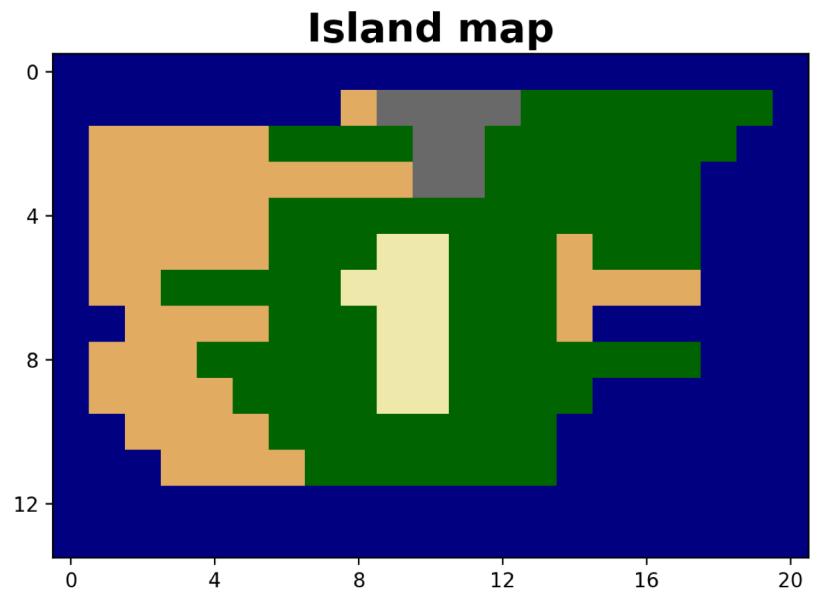
N M B U



Total number of herbivores: 4419

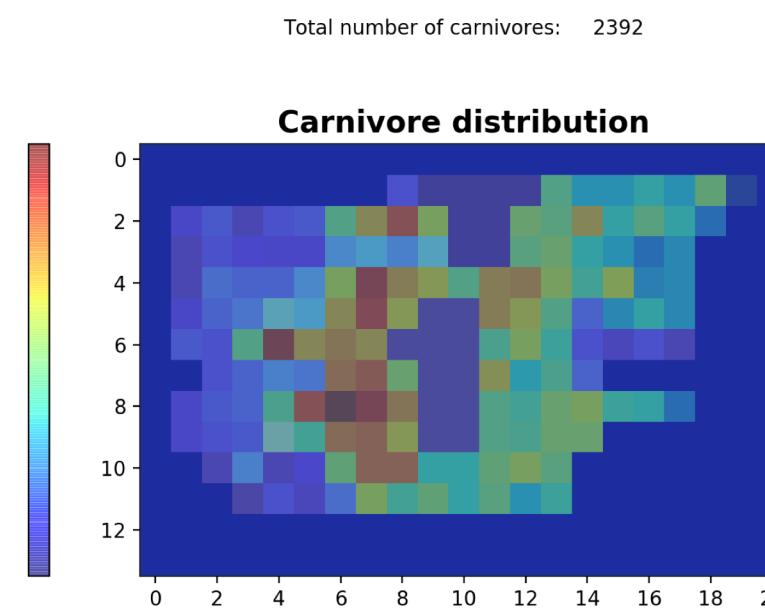
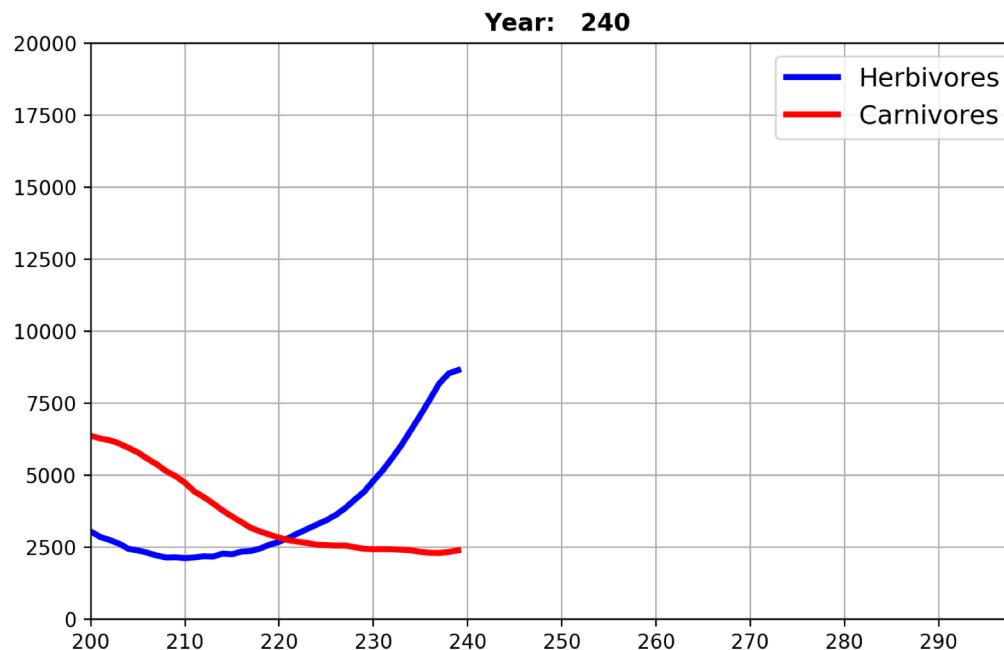


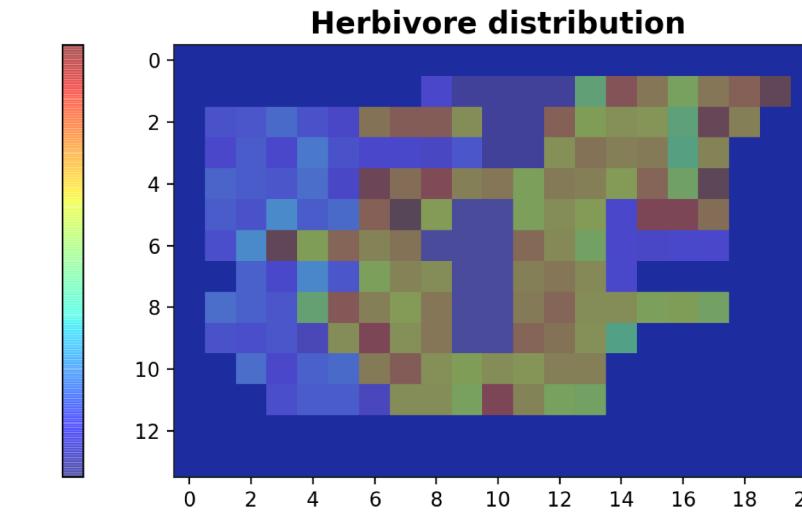
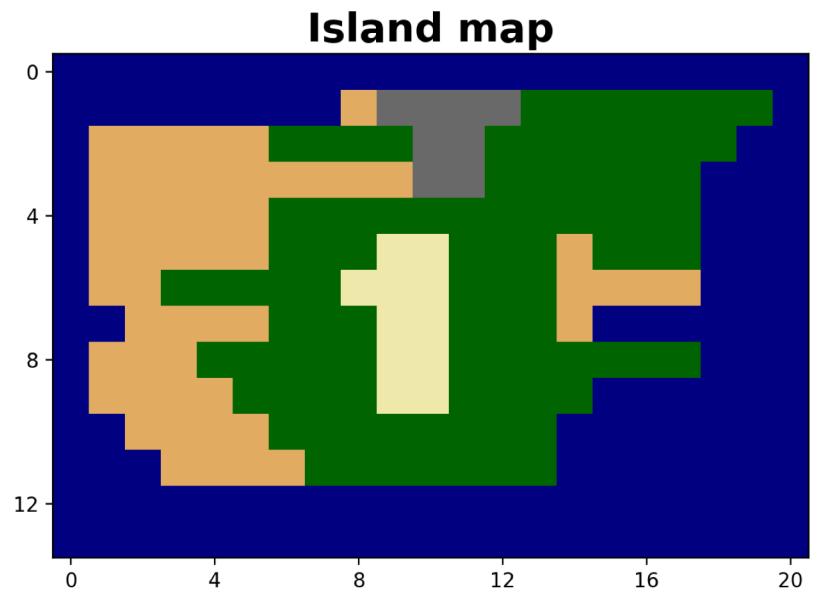
Total number of carnivores: 2449



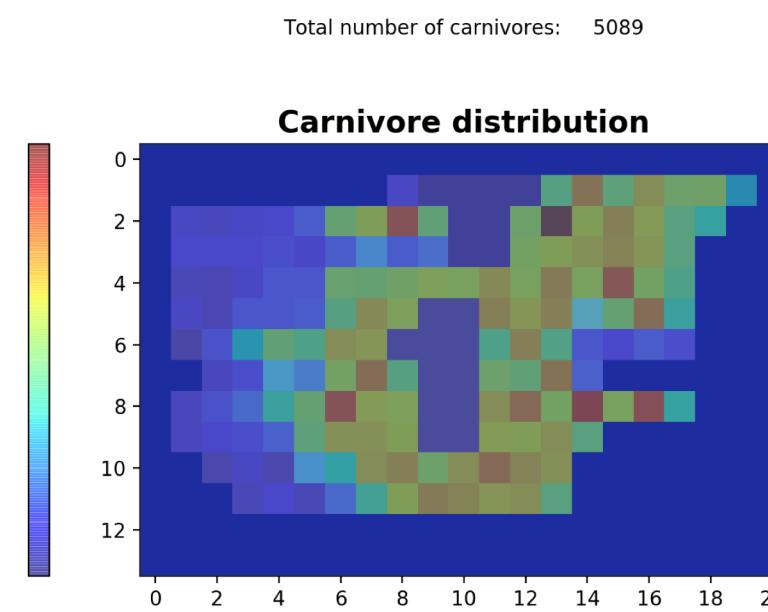
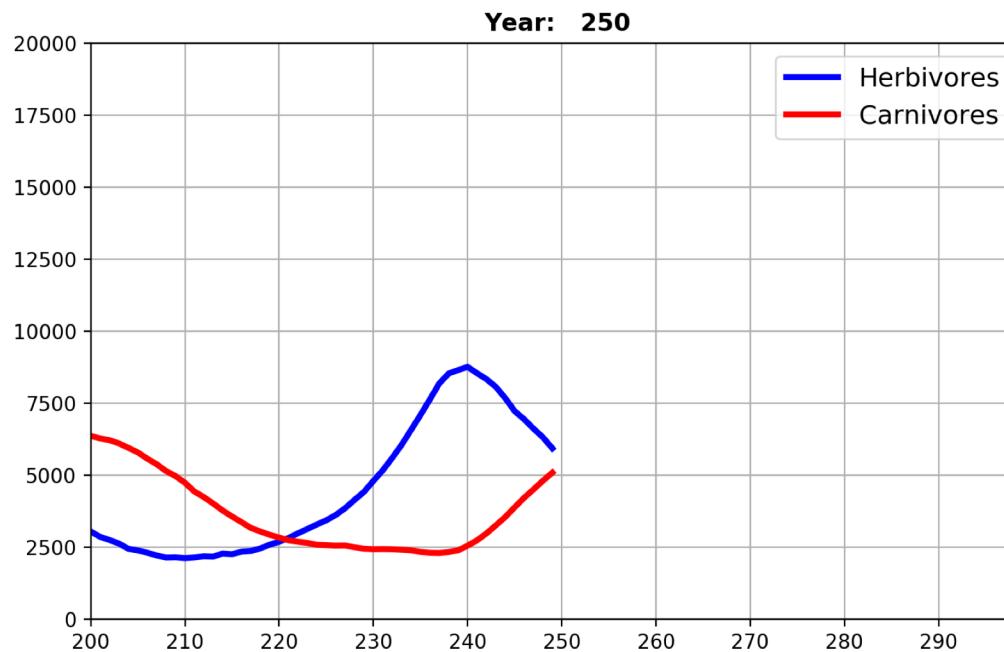
A legend identifying points A, B, M, N, and U:

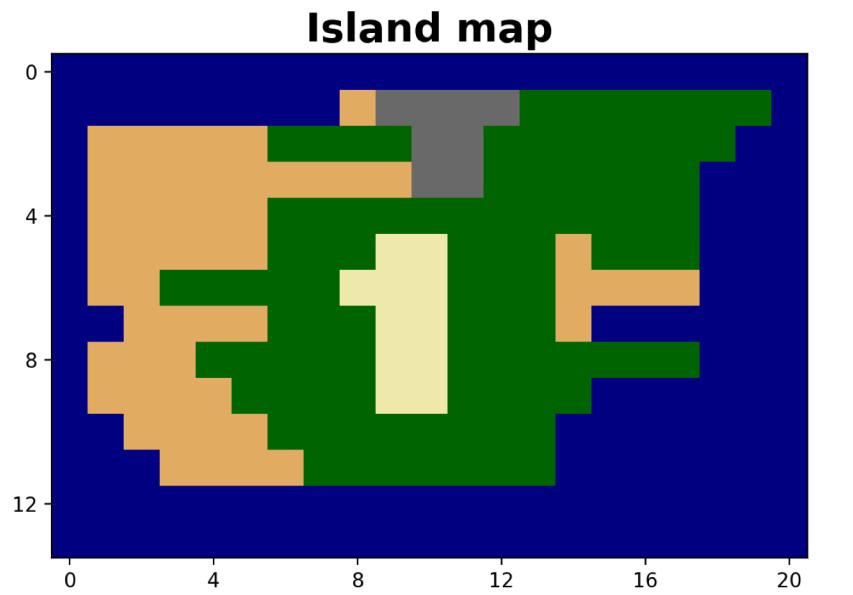
- A: (8, 1)
- B: (12, 1)
- M: (12, 8)
- N: (8, 8)
- U: (18, 1)



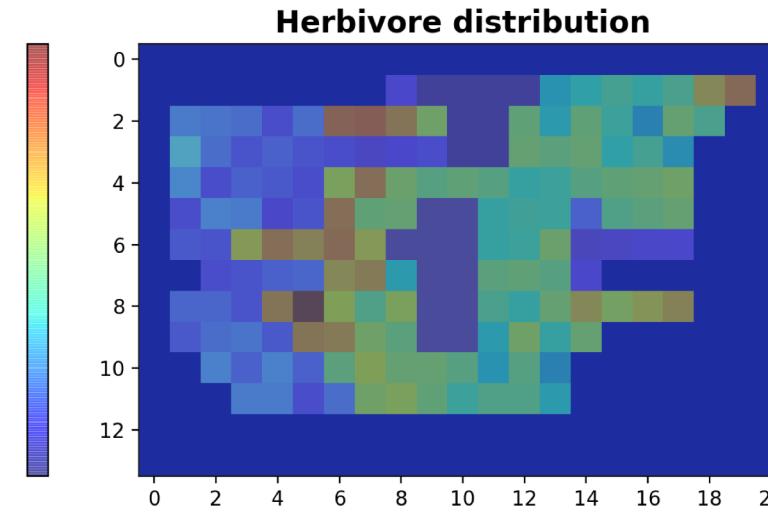


N M B U

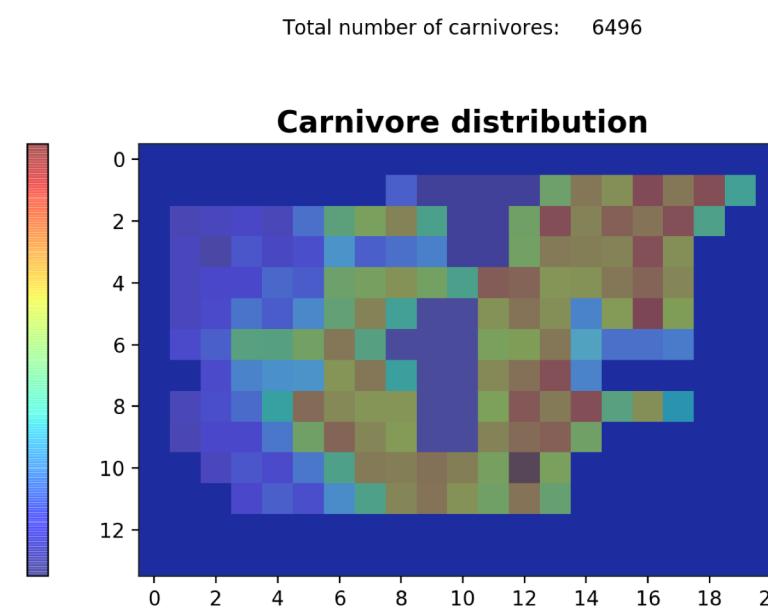
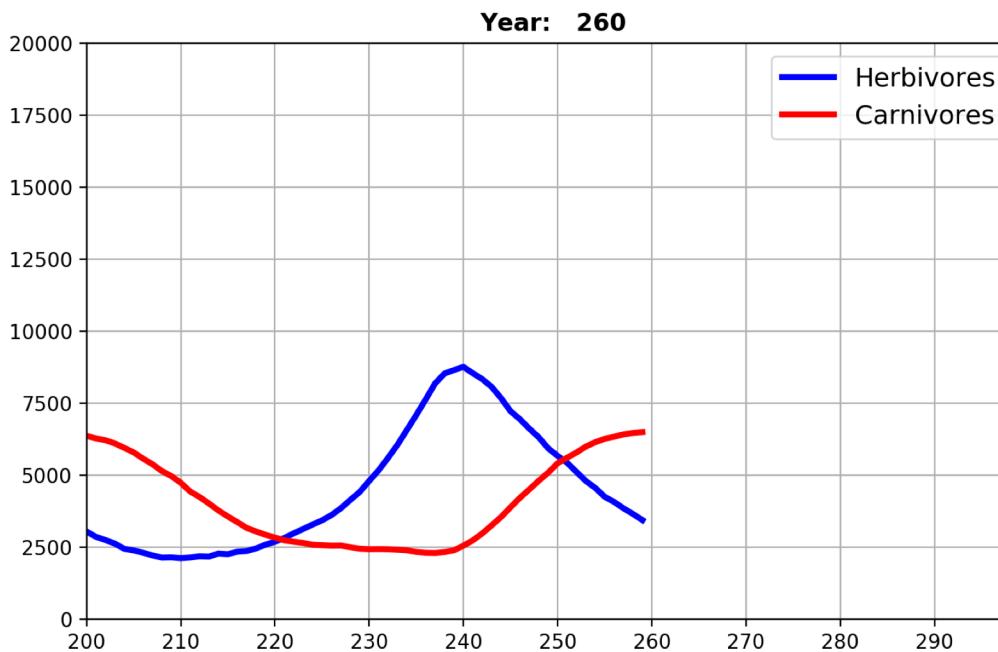




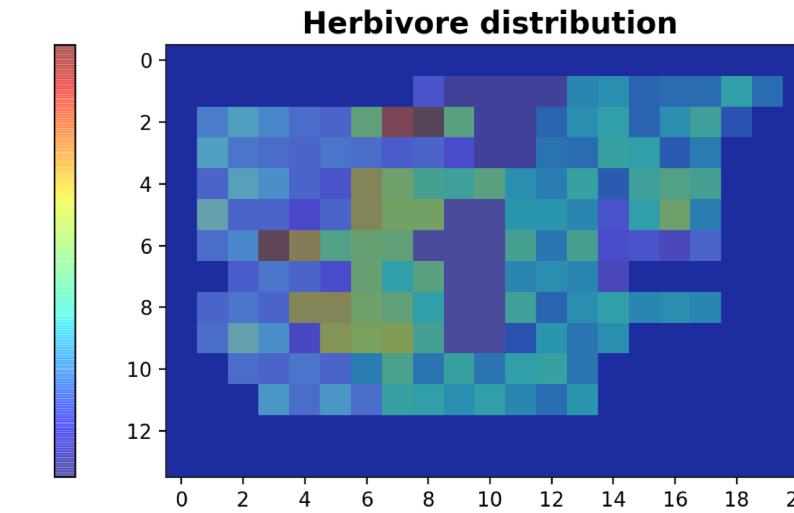
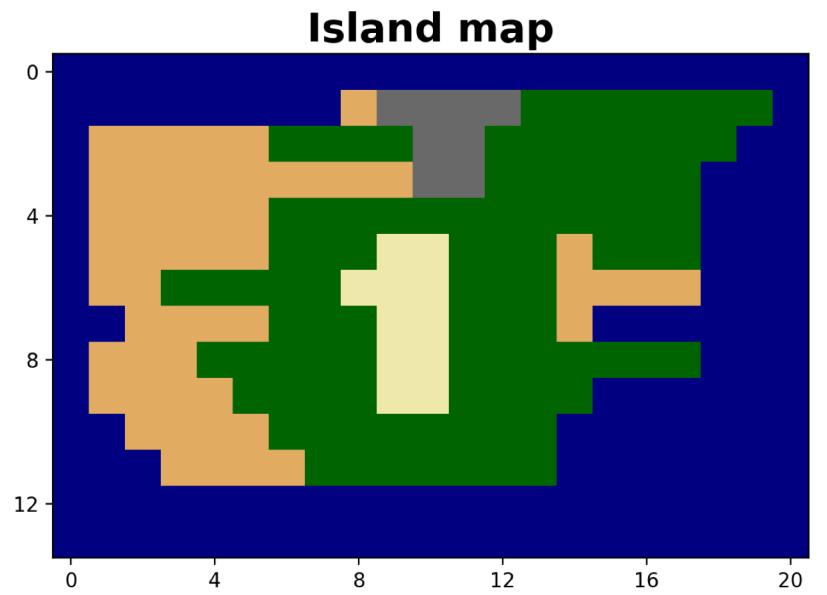
- Desert
- Savannah
- Jungle
- Mountain
- Ocean



Total number of herbivores: 3441

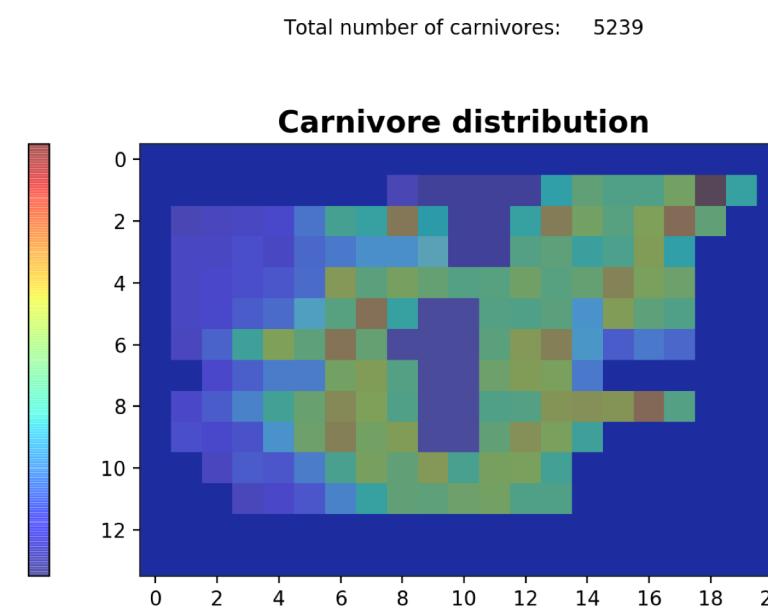
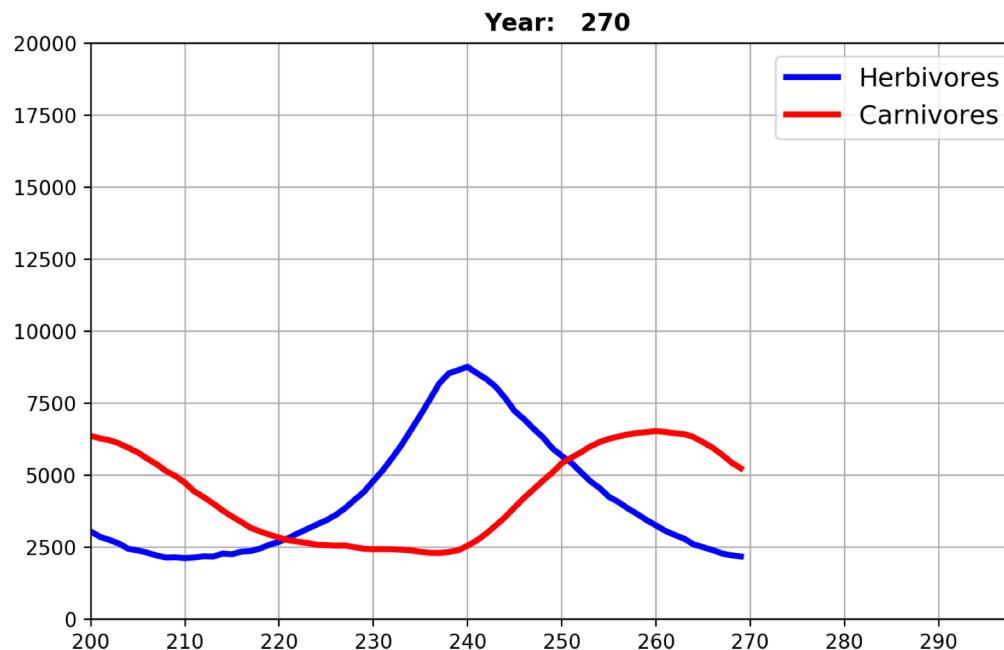


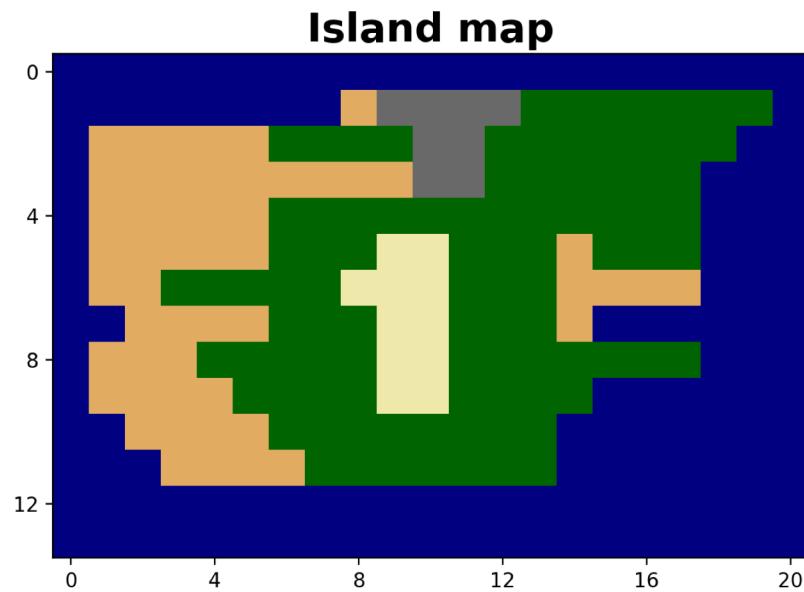
Total number of carnivores: 6496



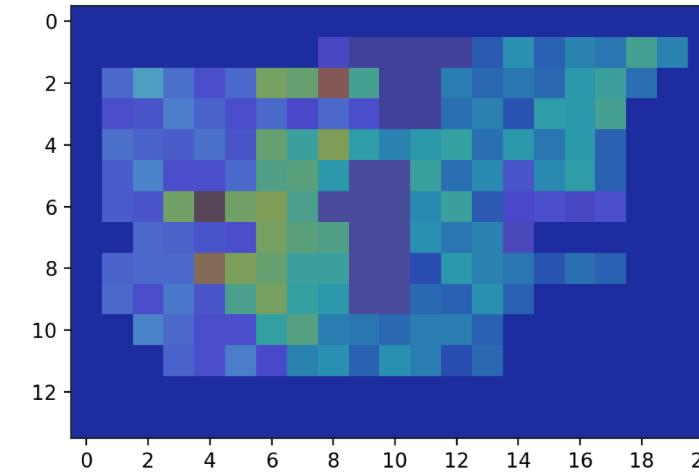
A legend identifying points A, B, M, N, and U with their respective coordinates:

- A: (8, 1)
- B: (9, 1)
- M: (10, 1)
- N: (10, 2)
- U: (10, 12)



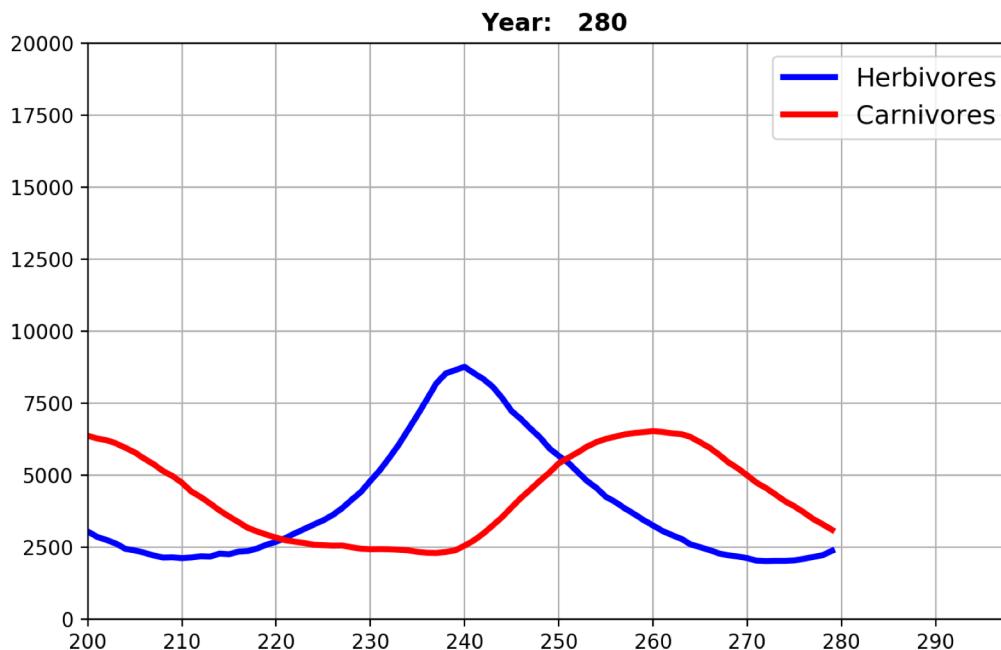


Herbivore distribution



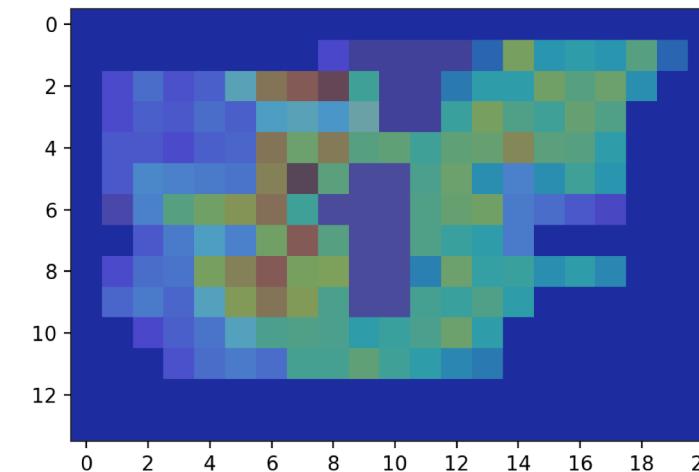
N M B U

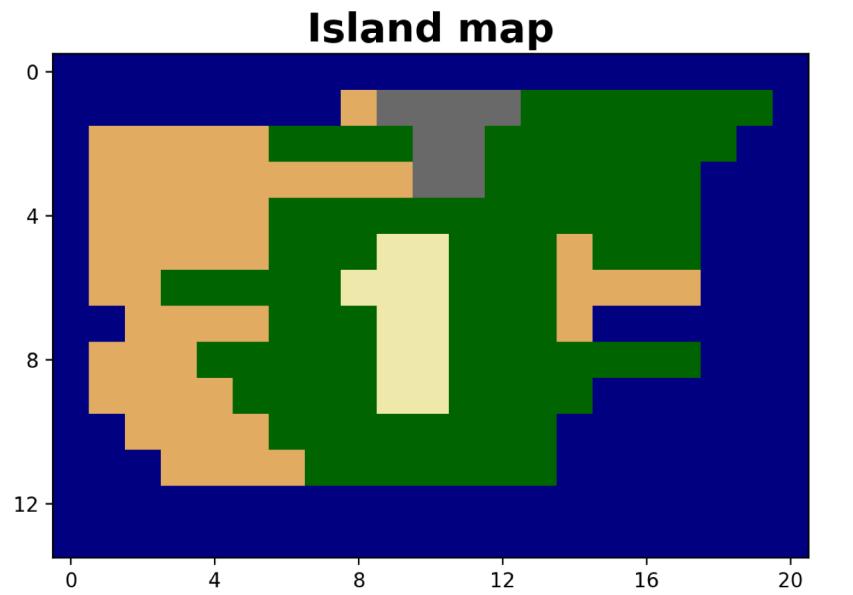
Total number of herbivores: 2375



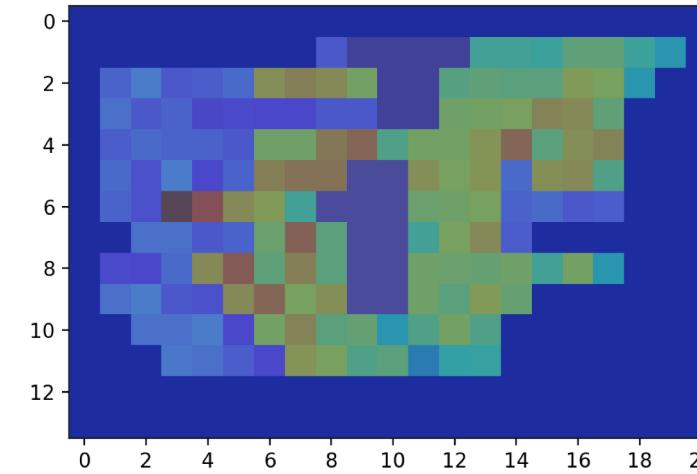
Total number of carnivores: 3104

Carnivore distribution

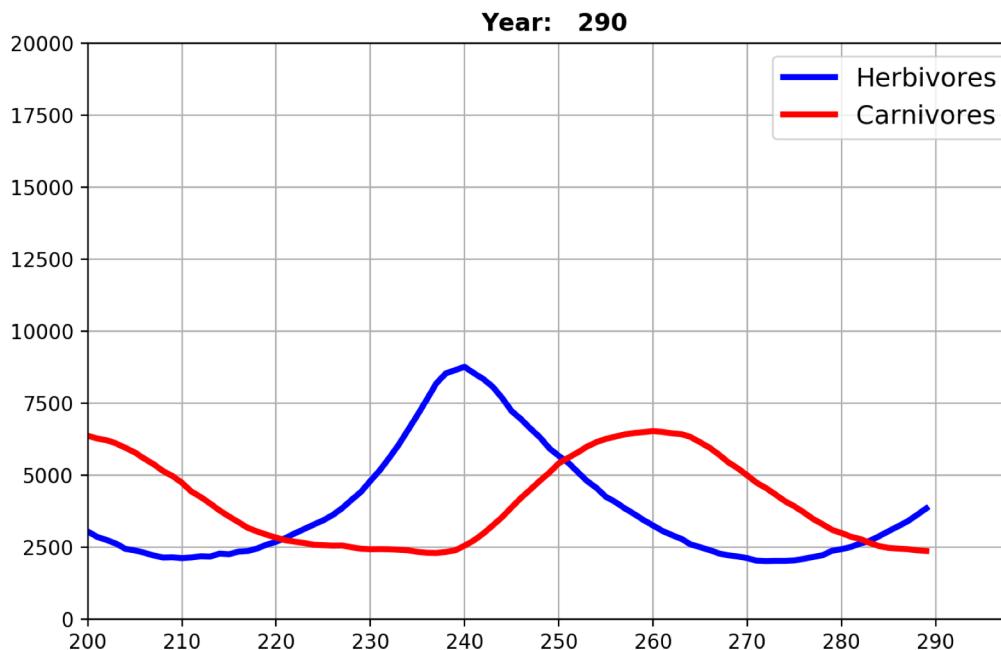




Herbivore distribution

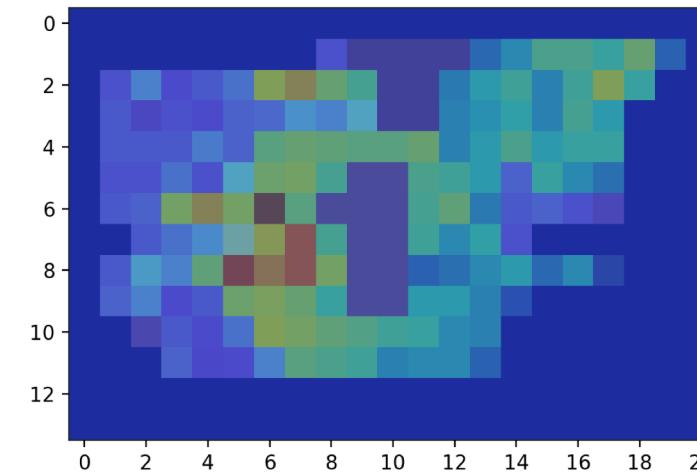


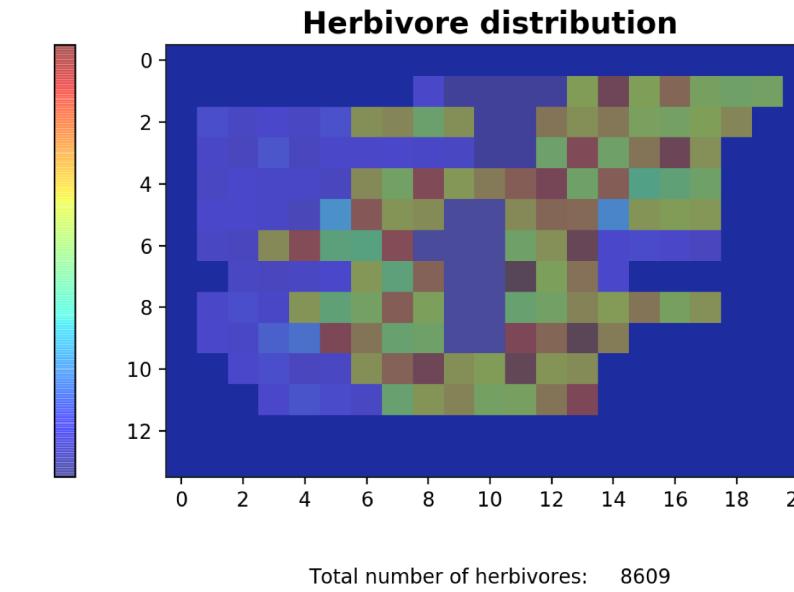
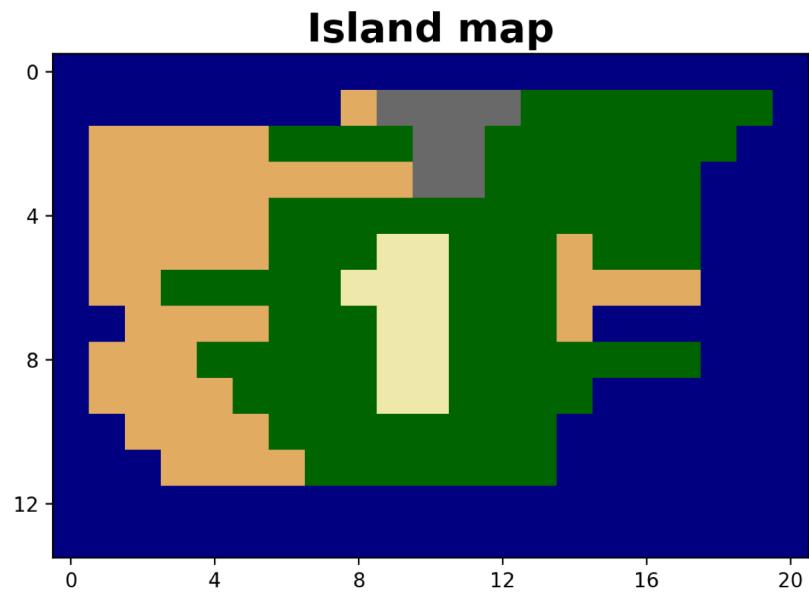
Total number of herbivores: 3849



Total number of carnivores: 2367

Carnivore distribution





N M B U

