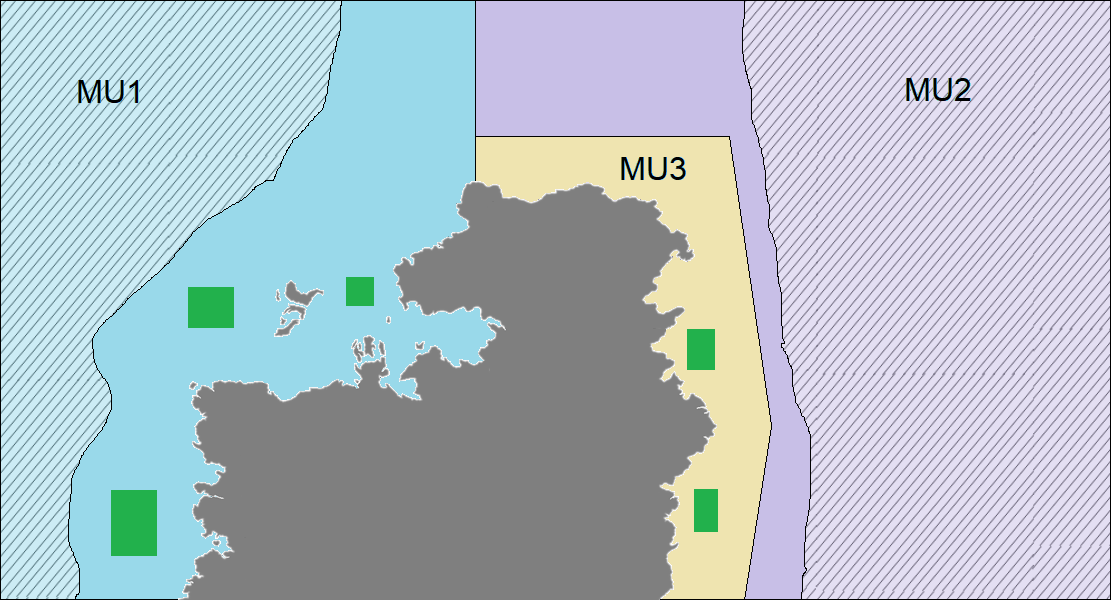
**Exercise 1. Spatial Definition of Stock/Data-limited Methods**

**Exercise Goal:**

1. Identify ways to approach defining an LRP for a data-limited “Arctic sardine” stock, where the “stock” area contains multiple management components.

The fictional Arctic sardine stock consists of three management units (Figure 1) but would be prescribed to the Fish Stocks Provisions as a single stock. A single LRP will be required for the stock. Data types and coverage differs among the three management components (Table 2). Most of the stock landings are taken from MU1 (~75% of landings). Consequently, MU1 is the primary focus of data collection and reporting.



Common overwintering area

Common spring/summer feeding area

**Figure 1. Map of the Arctic sardine management units (MU1, MU2, MU3).**

Green polygons = known spawning areas and locations of acoustic surveys during the spawning season

Hatched area = groundfish bottom trawl survey coverage in MU1 and MU2

Seasonal migration pattern:

All MUs share a common overwintering area (orange polygon), migrate north and share a common spring/summer feeding area (red polygon), and separate in the fall by returning to their natal spawning grounds (green polygons). The specific spawning locations are unknown in MU2.

Consider the following two approaches of defining an LRP for the Arctic sardine stock:

* An LRP based on the entire stock that includes all three management units.
* An LRP based on MU1 only.

**Candidate Criteria for Best-Practice Indicators and LRPs:**

* Consistent with an objective to avoid serious harm to the stock
* Based on the best available information
* Operationally useful
* Reliably estimated

**Terminology Reminder:**

An "indicator" is some measurement that provides information on the state of the stock, and may include model-based estimates of biomass, fishing mortality or exploitation rate, or suitable proxies for these such as survey indices. An LRP is some value of an indicator that represents a threshold that management measures aim to avoid.

**Exercise Questions:**

1. Evaluate and list the pros and cons of the data types (e.g., catch, CPUE, bottom trawl survey index, acoustic survey index) as indicators of stock abundance, noting that they have different temporal and spatial coverage and keeping in mind that the Arctic sardine is a schooling pelagic fish with seasonal migrations.
2. Select a spatial area (entire stock or MU1 only) and define an LRP for that area using an indicator generated from the dataset. If more than one LRP is considered, evaluate the pros and cons of each.
3. As a group, prepare a 1-2 slide (< 5 minute) presentation to explain

* The spatial area chosen – pros/cons of choice
* The preferred stock status indicator – pros/cons of choice
* The preferred LRP and rationale for choice (including how the choice reflects candidate best practice criteria)
* Include a time series plot of the indicator and add a line to represent the LRP.
* Put on your manager hat and describe how the LRP could be operationalized by identifying a measurable objective related to the LRP (e.g., consider risk tolerance, time frames) and performance statistic.
* What are the assumptions needed to select a single LRP for the stock, and what are the consequences of a failure of assumptions? (e.g., rRisk of “scale mismatch of control” where scale of ecological processes does not match scale of management).

**Table 1. Data Files for Exercise 1**

|  |  |  |
| --- | --- | --- |
| File Type | File Name | Description |
|  | Exercise 1 Background Figures.html | Fishery background and figures |
| CSV layer | ex1\_landings.csv | Landings by MU and year |
| CSV layer | ex1\_indices.csv | Purse seine catch and effort for MU1 by year  Survey indices for entire stock are and MU1 by year |
| C:\Users\barretttj\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\3B9046F.tmp | ex1.R | R script that imports data with plots and calculations started |
| C:\Users\barretttj\AppData\Local\Microsoft\Windows\INetCache\Content.MSO\3B9046F.tmp | functions.R | R script with functions (in main LRP directory) |

**Table 2. Data scenario by area**

|  |  |  |  |
| --- | --- | --- | --- |
| **MU** | **Indicator** | **Data File and Column** | **Units** |
| Entire stock area | Landings (years 1-50) | ex1\_landings.csv  Landings\_kt | kt |
| Relative index of total (benthic) biomass from groundfish bottom trawl survey (years 9-50)  [index covers part of MU1 and MU2] | ex1\_indices.csv  BT\_Index\_MU1\_2 | kt |
| Relative index of SSB from acoustic surveys on the spawning grounds (years 26-50)  [index covers spawning grounds in MU1 and MU3, spawning locations unknown in MU2] | ex1\_indices.csv  Ac \_Index\_MU1\_3 | kt |
| MU1 | Total Landings (years 1-50) | Can be obtained from ex1\_landings.csv | kt |
| Purse Seine Landings (years 1-50) | ex1\_indices.csv PS\_Catch\_MU1 | kt |
| Purse Seine Effort (years 11-50) | ex1\_indices.csv PS\_Effort\_MU1 | # of trips |
| Relative index of total (benthic) biomass from groundfish bottom trawl survey (years 9-50)  [index covers part of MU1] | ex1\_indices.csv BT\_Index\_MU1 | kt |
| Relative index of SSB from acoustic surveys on the spawning grounds (years 26-50)  [complete coverage of spawning areas in MU1] | ex1\_indices.csv Ac\_Index\_MU1 | kt |