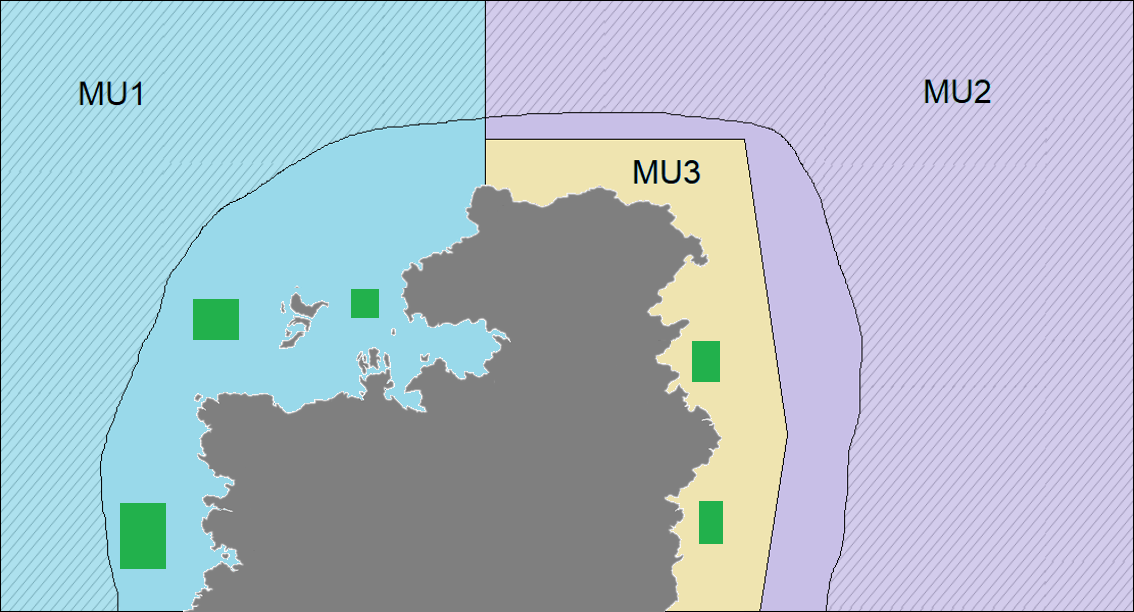
**Exercise 1. Spatial Definition of Stock/Data-limited Methods**

**Exercise Goal:**

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

The fictional small pelagic Arctic Sardine (Pseudosardina arctica) stock consists of three management units (MUs; Figure 1) and is a candidate for prescription under the Fish Stocks Provisions. A single LRP and stock status will be required for the stock. Data types and coverage differs among the three MUs (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.



Unknown

spawning

areas

Common overwintering area

Common spring/summer feeding area

**Figure 1. Map of the Arctic Sardine Stock Area and Management Units (MU1, MU2, MU3).**

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

Hatched area = spring 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.

**Tips:**

Consider how data collection for each candidate indicator overlaps with Arctic Sardine in space and time.

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| **Exercise Activities:**   1. On the Powerpoint File in the exercise folder. Characteristics of the various data types (e.g., catch, CPUE, bottom trawl survey index, acoustic survey index) are listed in text boxes on Slide 2. Copy and paste the text boxes to the pros or cons column for indicators of stock abundance and add your own pros/cons if you identify others. Note that the indicators have different temporal and spatial coverage and keep 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, complete the presentation slides of the Powerpoint File. The last slide will be presented by a group member at the beginning of the workshop tomorrow. Explain:    1. The **spatial area** chosen – pros/cons of choice    2. The preferred stock status **indicator** – pros/cons of choice    3. The preferred **LRP** and **rationale** for choice       * Did the choice reflect any candidate **best practice** criteria?    4. Include a time series plot of the indicator and add a line to represent the LRP.    5. 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 associated metrics of stock status: “P(Indicator > LRP) > p after X years”).    6. Regardless of spatial area chosen for the LRP, at which spatial scale what would you recommend Arctic Sardine be **prescribed** (the entire stock or MU1 only) and why?    7. 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., risk of serial depletion where scale of ecological processes does not match scale of management). |

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

|  |  |  |
| --- | --- | --- |
| File Type | File Name | Description |
| Microsoft PowerPoint 2016 - Review 2016 - PCMag UK | BO Group Ex1.pptx | Powerpoint for group exercise and presentation |
|  | 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 |