# Appendix 1

# Case Study: Application of WWF Canada's National Classification for Marine Conservation to the Scotian Shelf

## Introduction

This case study on the Scotian Shelf of Canada was undertaken in 1998 to test the national marine classification system developed in this report (Part 3, Table 3), using the best information available. The case study was jointly funded by the Department of Fisheries and Oceans, Parks Canada and WWF Canada, and is based on a previous case study on the Scotian Shelf by Geomatics International (1997).

This case study encompasses the marine waters adjacent to southern Nova Scotia, including the Bay of Fundy, extending to the boundary of Canada's exclusive economic zone (EEZ) (see Map 1). The northern limit of the study area is the Laurentian Channel, east of Cape Breton Island, and the eastern limit includes part of Georges Bank. The total area of this region is approximately 316,000 square kilometres.

## Methodology

In some cases, the required data for the Scotian Shelf either were not available or were in a format that could not be adapted to exactly match the parameters listed in Table 3B1. Therefore, data used in certain levels in this case study are not strictly consistent with those outlined in the report; however, in each case the substitute data are assumed to be a reasonable surrogate for those listed in Table 3B1. More consistent data should be used as they become available. The framework used for the Scotian Shelf case study is indicated in Table A1 below.

Notable inconsistencies from the national classification in Table 3 are as follows:

- **Level 3: Temperature (Map 2)** The winter surface isotherm of 0°C was used as an approximation for the seasonal ice limit.
- **Level 4: Sea-Ice Cover (Not mapped**) The Scotian Shelf was considered not to have sea-ice cover; this level, therefore, was not relevant to the case study.

- **Level 6b: Benthic Temperature (Map 6)** This level representing benthic temperature was introduced into the case study on the basis of expert opinion. Benthic temperature is not part of the national framework; however, it was deemed to be a unique and important factor for the study area.
- **Level 7: Mixing and Wave Action—Pelagic Stratification (Map 7)** Calculated values of density anomalies were used as a surrogate for the stratification parameter. Density anomalies were calculated as 1500 (rate of change of density with respect to depth) on the basis of water densities in the month of August.
- **Level 7: Mixing and Wave Action—Benthic Exposure (Map 8)** In the national classification, Level 7 (mixing and wave action) indicates that waters less than 50 metres in depth are subject to three exposure classes: exposed (fetch > 500 km); moderately exposed (fetch > 50 km, < 500 km); and sheltered (fetch < 50 km). Although these exposure classes are important determinants of community types, mapping the three classes would require a finer scale of analysis than was undertaken in this case study. Therefore, all waters less than 50 metres in depth were mapped as subject to exposure, but no further analysis was done. A finer analysis of exposure would be important for any coastal planning exercise.
- **Level 8: Benthic Substrate (Map 9)** Available data for this level could not be reclassified accurately into the three classes prescribed in the national classification (clays/silts, sand/pebbles, cobble/boulders). Five classes (mud, mostly sand, partially sand, partially gravel and mostly gravel) were used instead.

## RESULTS

Maps 2, 3 and 4 illustrate two levels of the hierarchy that, when combined (Map 5), define the marine natural regions. Maps 6 to 9 show the factors that, when combined, form seascapes, which are the fundamental or lowest unit of this classification system. Map 10 combines all the above levels, showing the marine natural regions and the seascapes for the Scotian Shelf. Map 10 reveals a total of nine natural regions and 62 seascapes.

As noted, there are still data gaps to be filled, such as near-shore sediment and exposure data, which should be added as they become available. Therefore, these seascapes should not be seen as definitive and should be refined as better data become available. Once refined, the seascapes and marine natural regions generated by this classification should be tested using independent data, including biological data and ecological data to determine whether there are affinities by species and, more importantly, by communities to marine natural regions and seascapes.

This classification was designed to be adaptable: available data can be incorporated and, where necessary, can be corrected by the addition of new data when they become available. The incorporation of additional information on substrates and benthic temperatures as unique factors for the Scotian Shelf indicates that the classification can be adapted successfully to reflect data availability and local conditions.

Table A1. **APPLICATION OF THE NATIONAL MARINE CLASSIFICATION TO THE SCOTIAN SHELF**

| LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 | LEVEL 5 |
|---|---|---|---|---|
| **Environment Type** | **Geographic Range** | **Temperature** | **Sea-Ice Cover** | **Segregation of Benthic and Pelagic Realms** |
| Marine | Atlantic | Boreal (avg. temp. > 0°C) | Not applied | Pelagic |
| | | Temperate (avg. temp. > 0°C, < 18°C) | | |
| | | Subtropical (avg. temp. > 6°C in winter, > 18°C in summer) | | |
| | | | | Benthic |

* Note: Density anomaly, da, is calculated as 1500 multiplied by rate of change of density with respect to depth. Density anomaly was used as a surrogate for the stratification parameter.

** Note: Slope determined for areas > 50 m in depth.

**WHERE TO FROM HERE?**

The seascapes defined in the case study can be used to aid in the selection and design of a representative system of MPAs, in concert with the principles and criteria outlined in Part 4 of this report. It is hoped that a map of seascapes such as Map 10 can provide an objective baseline on which to add further layers of information to aid in decision making. Ideally, many stakeholders and interested parties should be involved in the selection of candidate areas and should use as much extra biological, social and economic information as possible. However, to conserve biodiversity effectively in the long term, the ultimate goal of any MPA selection process or integrated planning exercise should be to ensure full representation of seascapes and marine natural regions.

| LEVEL 6<br>Vertical Segregation | LEVEL 6b<br>Benthic Temperature | LEVEL 7<br>Mixing and Wave Action | LEVEL 8<br>Benthic Substrate |
|---|---|---|---|
| **Pelagic** | | **Pelagic–Stratification*** | |
| Epipelagic<br>(0–200 m) | | Stratified (da > 1000) | |
| Mesopelagic<br>200–1000 m) | | Nonstratified (da < 100) | |
| (Bathypelagic (1000–2000 m) | | Frontal (100 < da < 1000) | |
| Abyssal/hadal (>2000 m) | | | |
| **Benthic** | | **Benthic-Exposure** | **Benthic–Sediments** |
| Euphotic (0–50 m) | Cold subarctic (< 6°C) | Exposure (depth < 50 m) | Mud |
| Dysphotic/aphotic<br>(50–200 m) | Moderate temperate<br>(6–9°C) | Benthic–slope** | Mostly sand<br>(20–80% sand) |
| Bathyl<br>(200–2000 m) | Warm Gulf Stream<br>(> 9°C) | High slope (slope > 2%) | Partially sand<br>(0–20% sand) |
| Abyssal/hadal<br>(>2000 m) | | Low slope<br>(slope < 2%) | Partially gravel<br>(5–50% gravel) |
| | | | Mostly gravel<br>(>50% gravel) |

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| | |
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*Proposed Methodology for Determination of Marine Representivity—Scotian Shelf and Surrounding Waters Pilot Study,* July 1997

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- ensuring that the use of renewable natural resources is sustainable
- promoting the reduction of pollution and wasteful consumption

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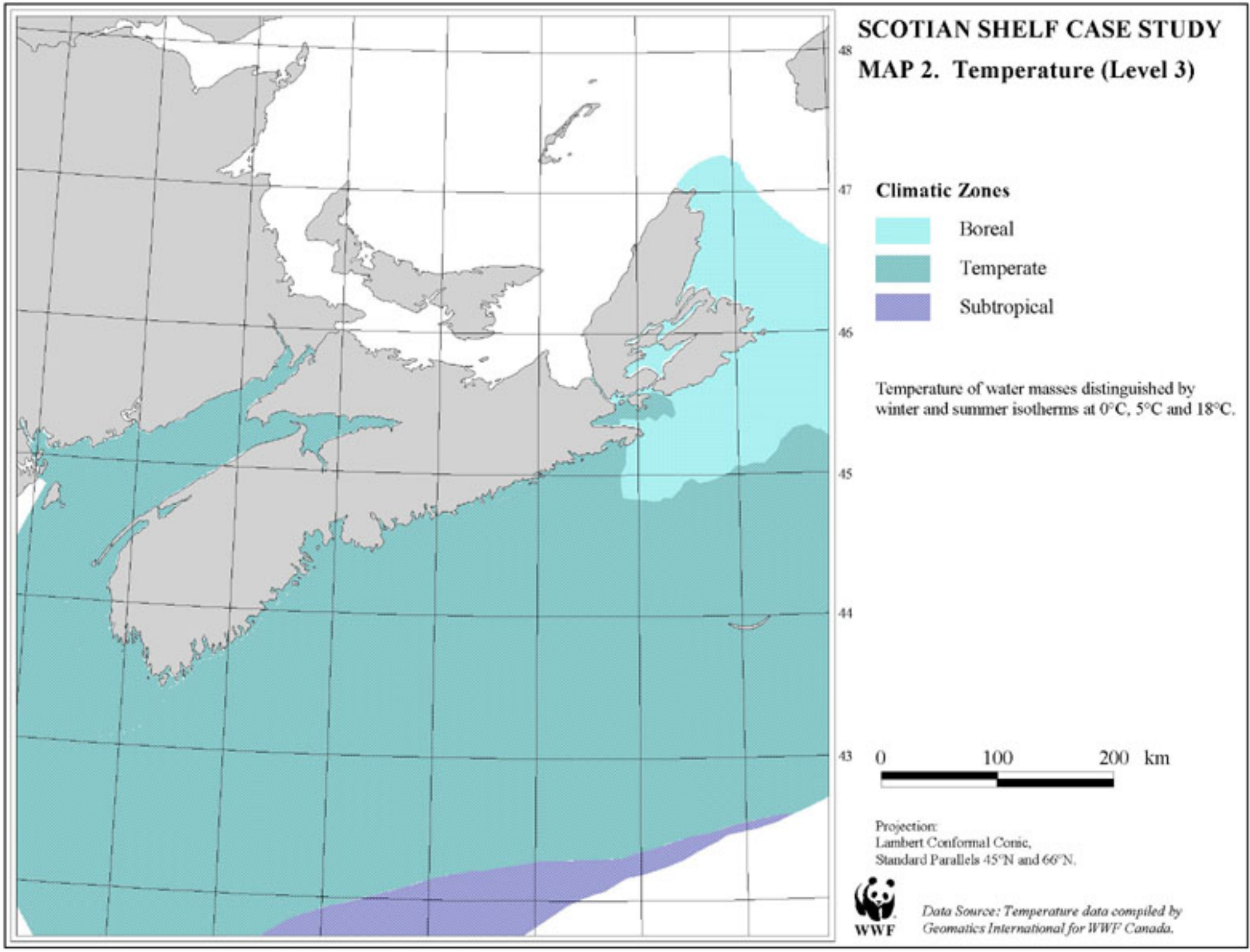
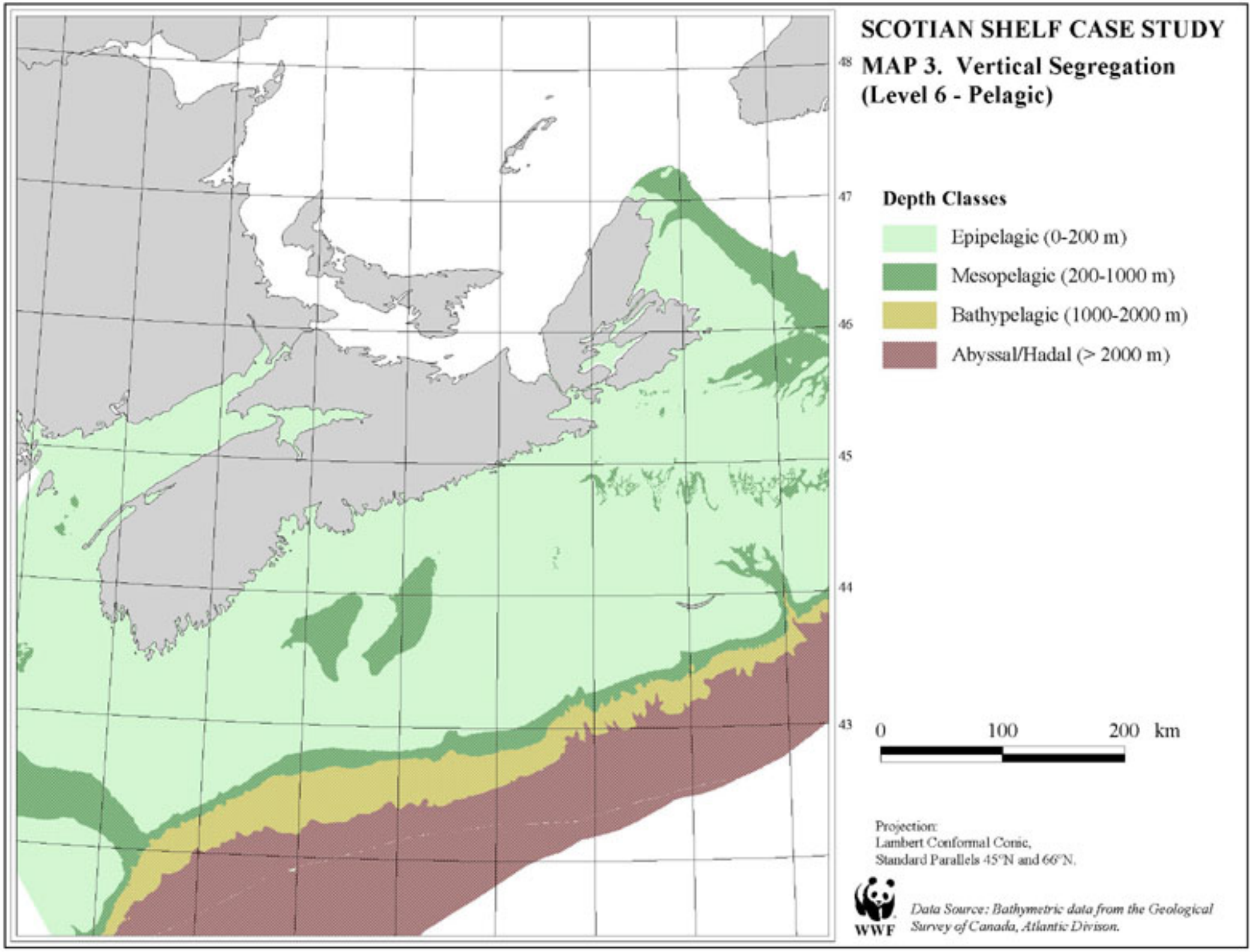
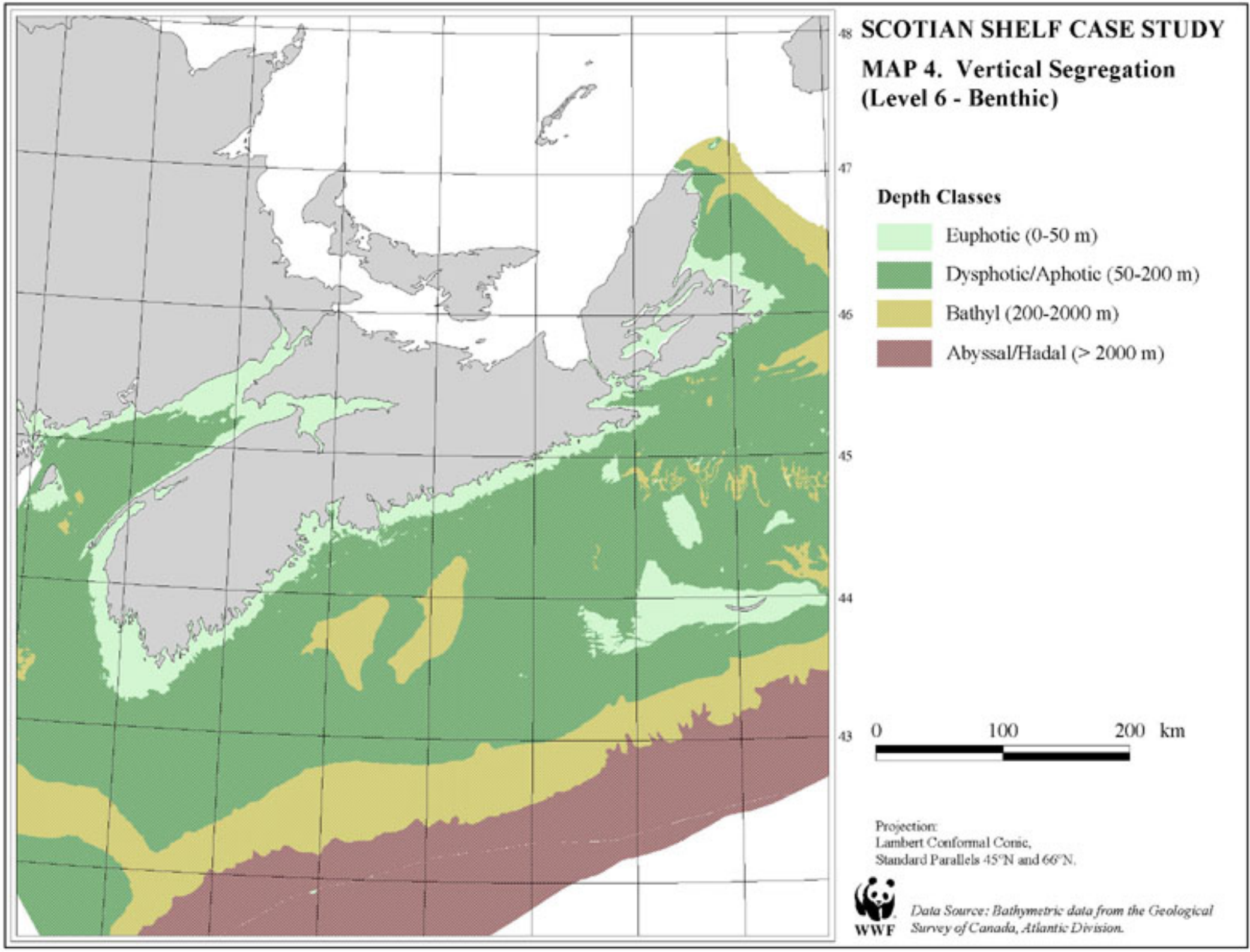
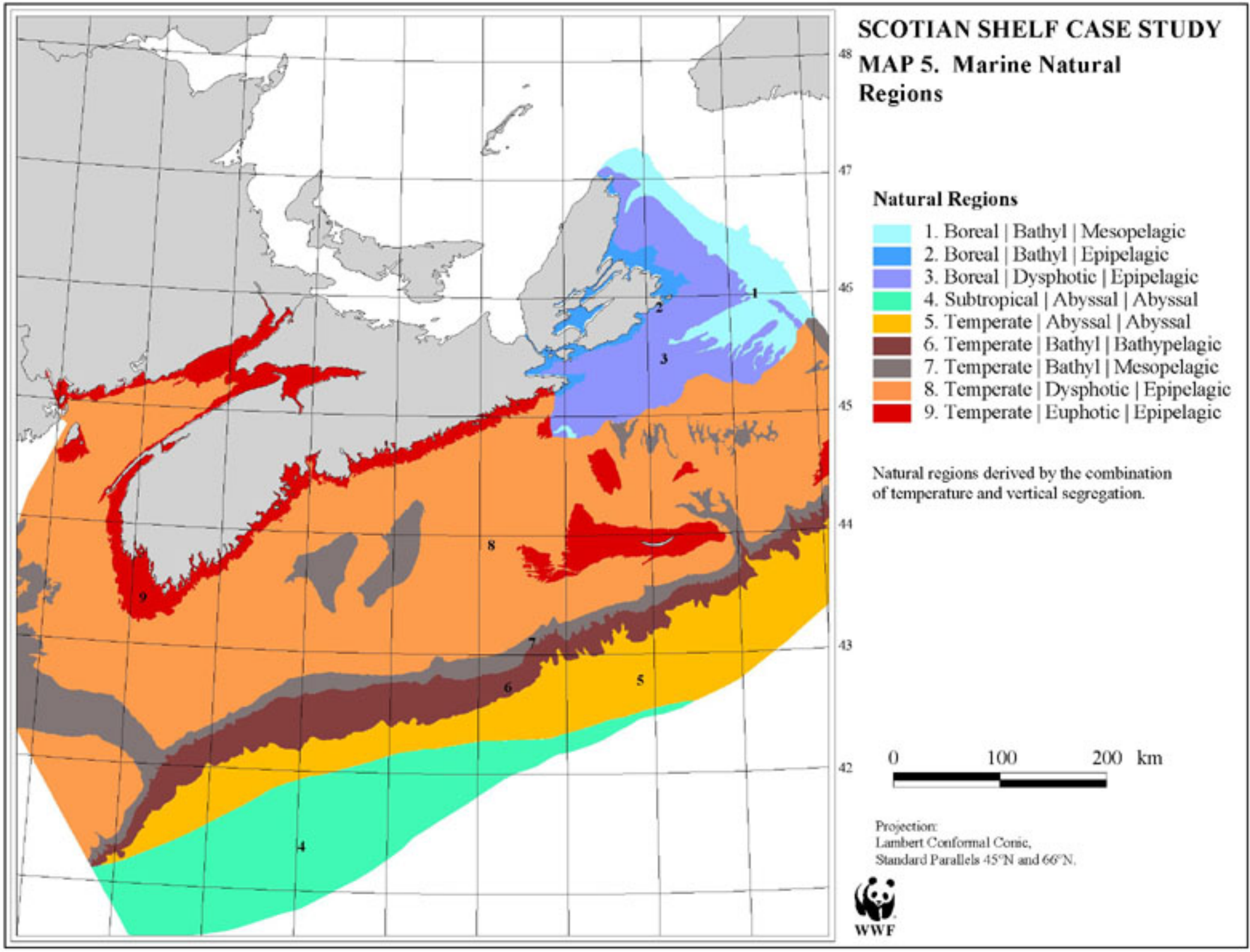
# SCOTIAN SHELF CASE STUDY

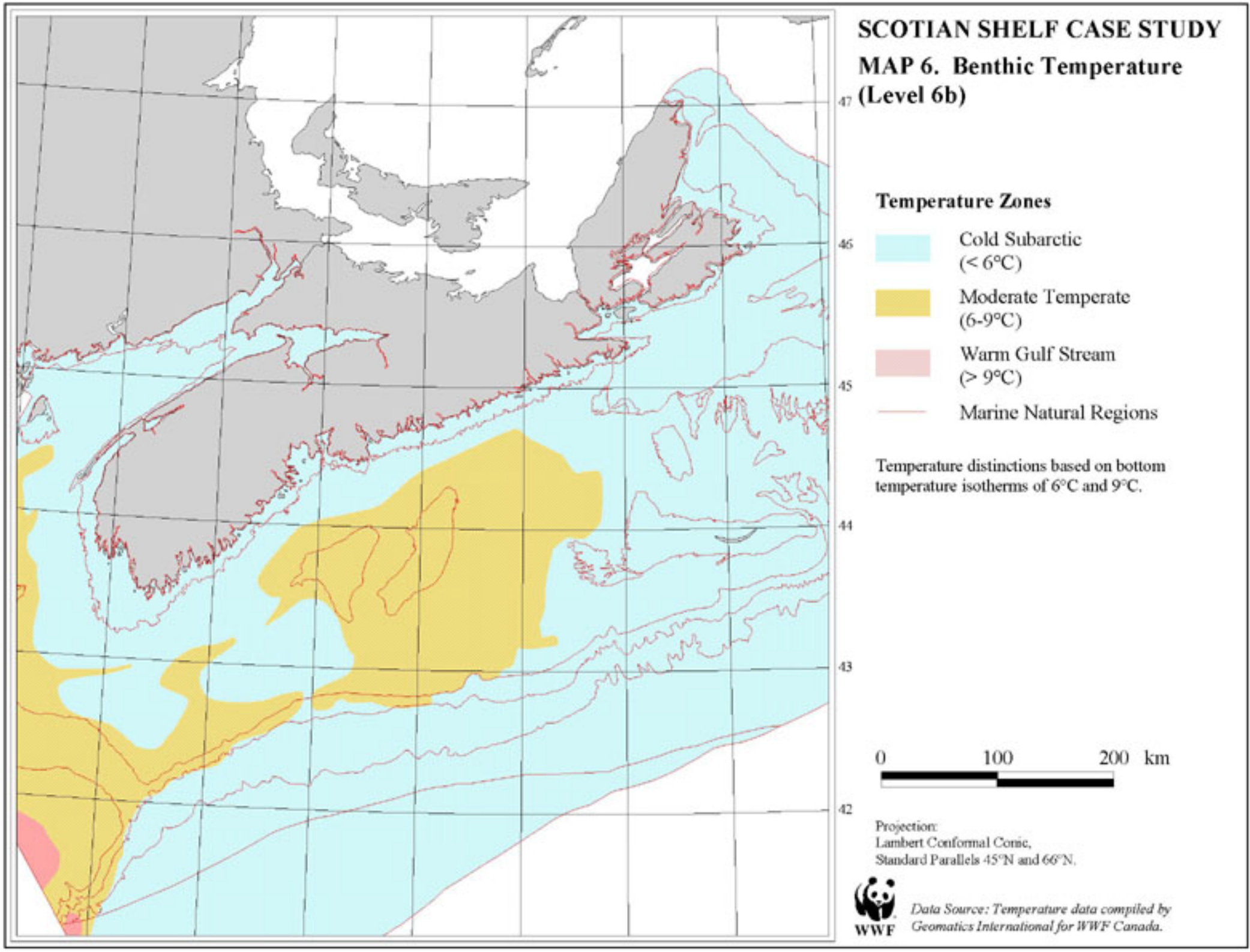
## MAP 1. Base Map

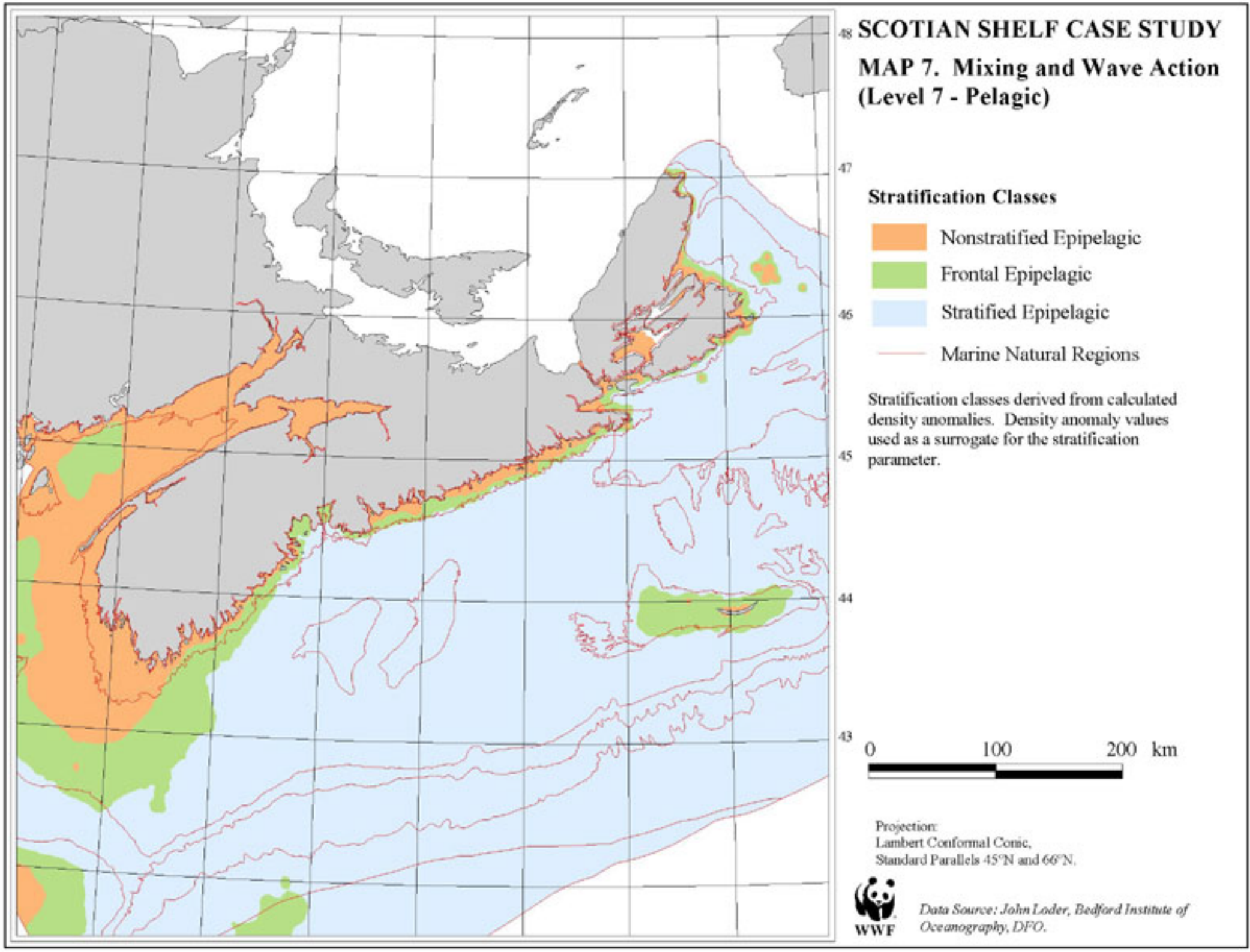

SCOTIAN SHELF CASE STUDY
MAP 2. Temperature (Level 3)
48
47
46
45
44
43
Climatic Zones
Boreal
Temperate
Subtropical
Temperature of water masses distinguished by winter and summer isotherms at 0°C, 5°C and 18°C.
0
100
200 km
Projection:
Lambert Conformal Conic,
Standard Parallels 45°N and 66°N.
WWF
Data Source: Temperature data compiled by Geomatics International for WWF Canada.

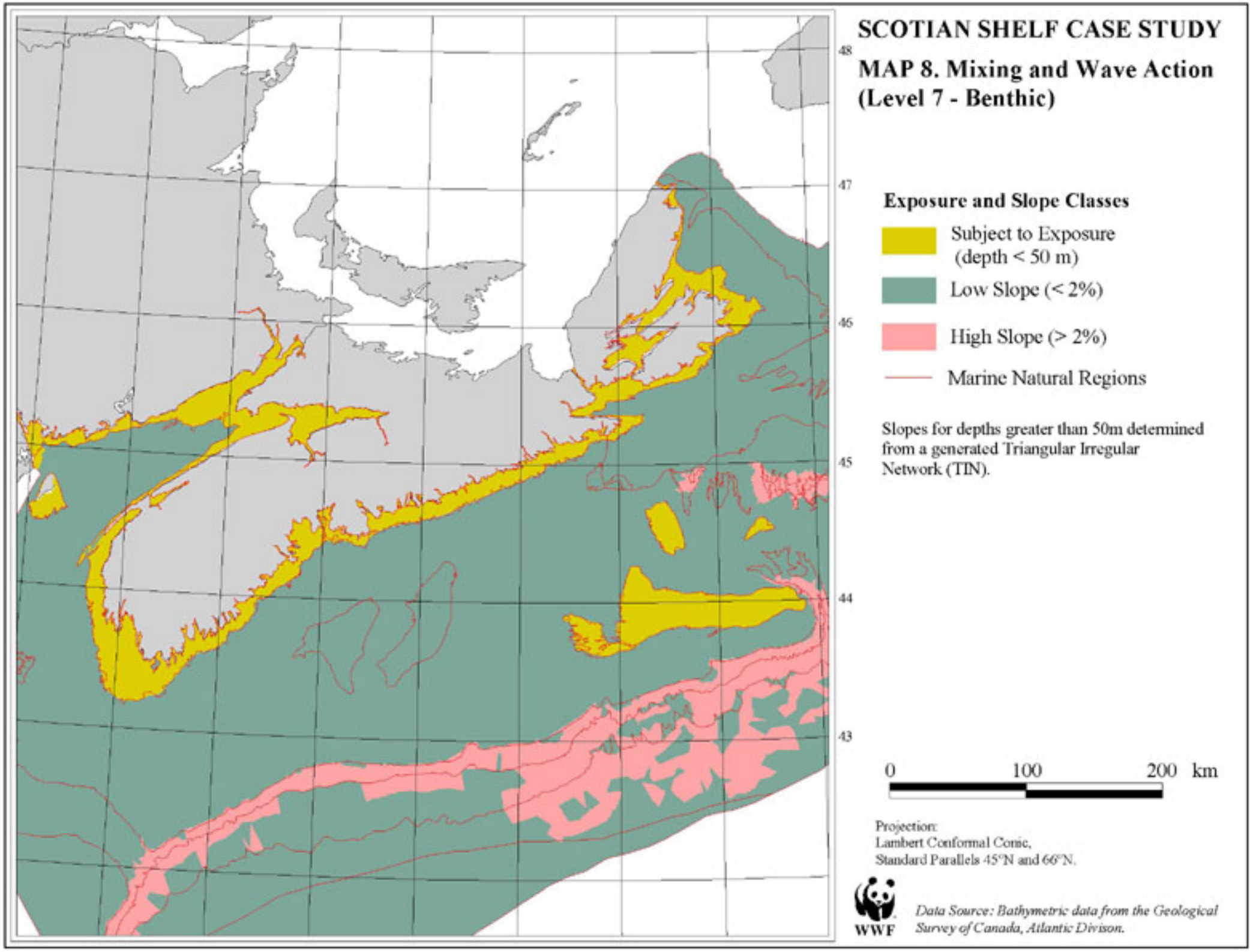

SCOTIAN SHELF CASE STUDY
MAP 3. Vertical Segregation
(Level 6 - Pelagic)
48
47
46
45
44
43
Depth Classes
Epipelagic (0-200 m)
Mesopelagic (200-1000 m)
Bathypelagic (1000-2000 m)
Abyssal/Hadal (> 2000 m)
0
100
200 km
Projection:
Lambert Conformal Conic,
Standard Parallels 45°N and 66°N.
WWF
Data Source: Bathymetric data from the Geological Survey of Canada, Atlantic Divison.

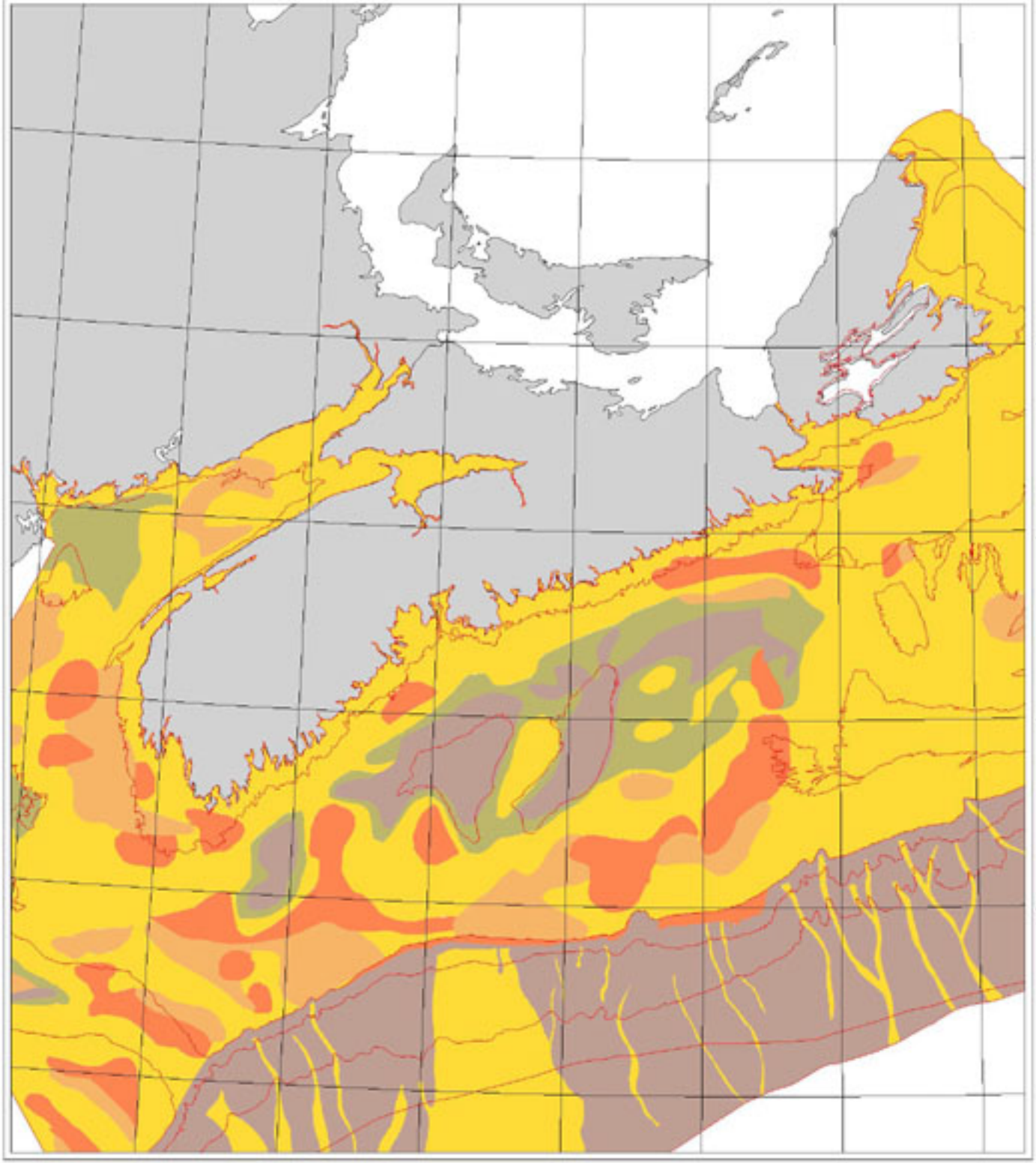

SCOTIAN SHELF CASE STUDY
MAP 4. Vertical Segregation
(Level 6 - Benthic)
48
47
46
45
44
43
Depth Classes
Euphotic (0-50 m)
Dysphotic/Aphotic (50-200 m)
Bathyl (200-2000 m)
Abyssal/Hadal (> 2000 m)
0
100
200
km
Projection:
Lambert Conformal Conic,
Standard Parallels 45°N and 66°N.
WWF
Data Source: Bathymetric data from the Geological Survey of Canada, Atlantic Division.


SCOTIAN SHELF CASE STUDY
MAP 5. Marine Natural Regions
Natural Regions
1. Boreal | Bathyl | Mesopelagic
2. Boreal | Bathyl | Epipelagic
3. Boreal | Dysphotic | Epipelagic
4. Subtropical | Abyssal | Abyssal
5. Temperate | Abyssal | Abyssal
6. Temperate | Bathyl | Bathypelagic
7. Temperate | Bathyl | Mesopelagic
8. Temperate | Dysphotic | Epipelagic
9. Temperate | Euphotic | Epipelagic
Natural regions derived by the combination of temperature and vertical segregation.
0 100 200 km
Projection:
Lambert Conformal Conic,
Standard Parallels 45°N and 66°N.
WWF
48
47
46
45
44
43
42
1
2
3
4
5
6
7
8
9


SCOTIAN SHELF CASE STUDY
MAP 6. Benthic Temperature (Level 6b)
47
46
45
44
43
42
Temperature Zones
Cold Subarctic (< 6°C)
Moderate Temperate (6-9°C)
Warm Gulf Stream (> 9°C)
Marine Natural Regions
Temperature distinctions based on bottom temperature isotherms of 6°C and 9°C.
0
100
200 km
Projection:
Lambert Conformal Conic,
Standard Parallels 45°N and 66°N.
WWF
Data Source: Temperature data compiled by Geomatics International for WWF Canada.


SCOTIAN SHELF CASE STUDY
MAP 7. Mixing and Wave Action
(Level 7 - Pelagic)
48
47
46
45
44
43
Stratification Classes
Nonstratified Epipelagic
Frontal Epipelagic
Stratified Epipelagic
Marine Natural Regions
Stratification classes derived from calculated density anomalies. Density anomaly values used as a surrogate for the stratification parameter.
0
100
200
km
Projection:
Lambert Conformal Conic,
Standard Parallels 45°N and 66°N.
WWF
Data Source: John Loder, Bedford Institute of Oceanography, DFO.


SCOTIAN SHELF CASE STUDY
MAP 8. Mixing and Wave Action
(Level 7 - Benthic)
48
47
46
45
44
43
Exposure and Slope Classes
Subject to Exposure
(depth < 50 m)
Low Slope (< 2%)
High Slope (> 2%)
Marine Natural Regions
Slopes for depths greater than 50m determined from a generated Triangular Irregular Network (TIN).
0
100
200 km
Projection:
Lambert Conformal Conic,
Standard Parallels 45°N and 66°N.
WWF
Data Source: Bathymetric data from the Geological Survey of Canada, Atlantic Divison.




# SCOTIAN SHELF CASE STUDY

## MAP 9. Benthic Substrate (Level 8)

**Sediment Classes**

- Mud
- Mostly Sand (20-80% sand)
- Partially Sand (0-20% sand)
- Partially Gravel (5-50% gravel)
- Mostly Gravel (> 50% gravel)
- Marine Natural Regions

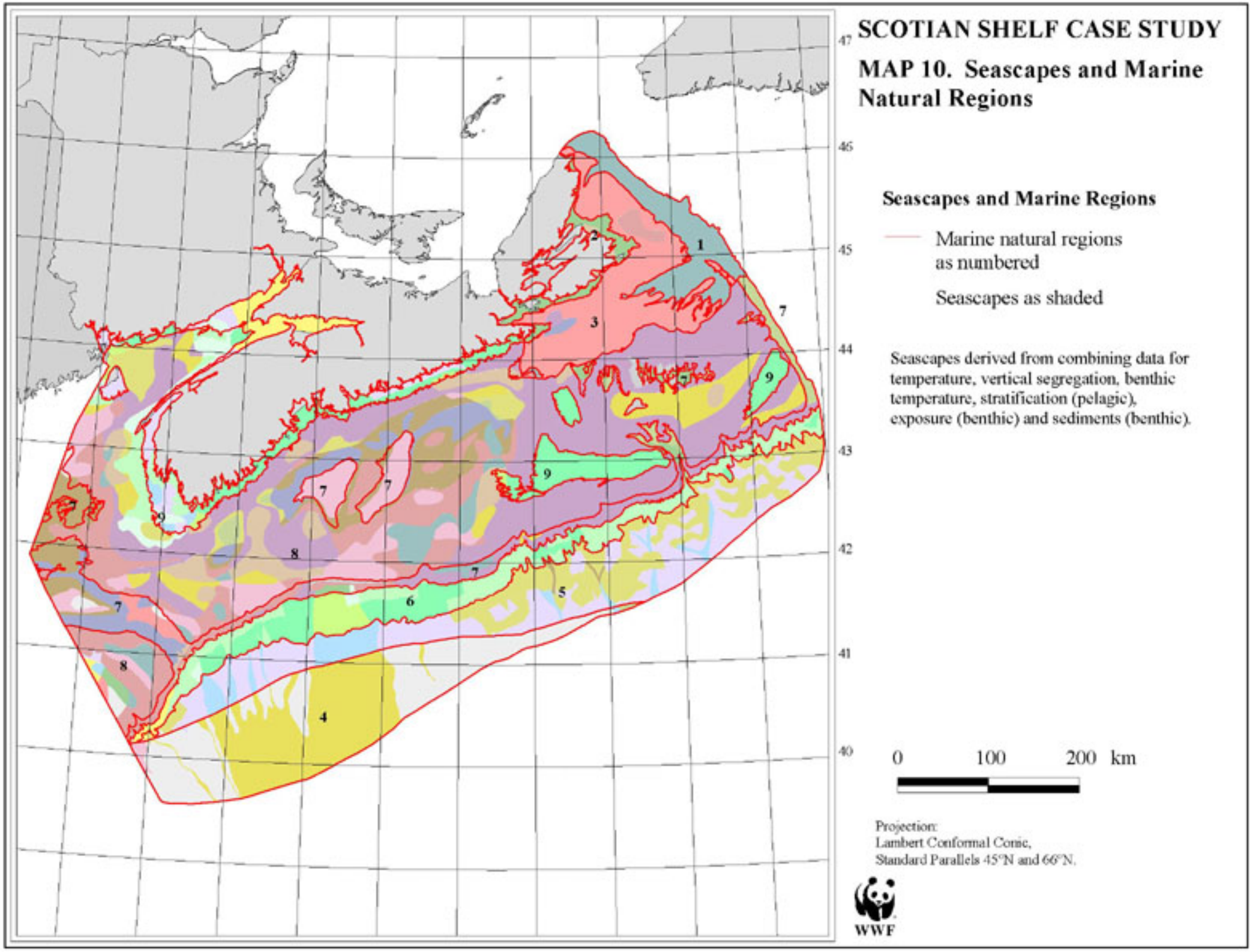
Note: The Benthic substrate classification is different from the prescribed classification. Modifications reflect availability of data.

0 100 200 km

Projection:
Lambert Conformal Conic,
Standard Parallels 45°N and 66°N.

WWF

*Data Source: Based on data provided by Carl Amos, Geological Survey of Canada.*


SCOTIAN SHELF CASE STUDY
MAP 10. Seascapes and Marine Natural Regions
Seascapes and Marine Regions
Marine natural regions as numbered
Seascapes as shaded
Seascapes derived from combining data for temperature, vertical segregation, benthic temperature, stratification (pelagic), exposure (benthic) and sediments (benthic).
0 100 200 km
Projection:
Lambert Conformal Conic,
Standard Parallels 45°N and 66°N.
WWF
47
46
45
44
43
42
41
40
1
2
3
4
5
6
7
8
9