TWAP
TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME

Transboundary Waters: A Global Compendium

Water System Information Sheets: Eastern Europe

Volume 6 - Annex E: Eastern Europe

UNEP

gef

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Volume 6-Annex E

Transboundary Waters: A Global Compendium

Water System Information Sheets: Eastern Europe

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UNESCO – United Nations Educational, Scientific and Cultural Organization · International Hydrological Programme

igrac – International Groundwater Resources Assessment Centre

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GLOBAL IGBP CHANGE – International Geosphere-Biosphere Programme

IUCN

SIWI

CUNY – The City University of New York

OSU – Oregon State University

Center for International Earth Science Information Network – Earth Institute | Columbia University

CESR – Center for Environmental Systems Research

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UNESCO – United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission

GLOBAL IGBP CHANGE – International Geosphere-Biosphere Programme

NOAA

GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection

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Sea Around Us

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Assessment Team: The Open Ocean

UNESCO – United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission

GOOS – Global Ocean Observing System

WCRP – World Climate Research Programme

GACS – Global Alliance of CPR Surveys

PML – Plymouth Marine Laboratory

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Water System Information Sheets: Eastern Europe

Contents (Volume 6, Annex E)

Preface

The Global Environment Facility (GEF) approved a Full Size Project (FSP), "A Transboundary Waters Assessment Programme: Aquifers, Lake/Reservoir Basins, River Basins, Large Marine Ecosystems, and Open Ocean to catalyze sound environmental management", in December 2012, following the completion of the Medium Size Project (MSP) "Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme" in 2011. The TWAP FSP started in 2013, focusing on two major objectives: (1) to carry out the first global-scale assessment of transboundary water systems that will assist the GEF and other international organizations to improve the setting of priorities for funding; and (2) to formalise the partnership with key institutions to ensure that transboundary considerations are incorporated in regular assessment programmes to provide continuing insights on the status and trends of transboundary water systems.

The TWAP FSP was implemented by UNEP as Implementing Agency, UNEP's Division of Early Warning and Assessment (DEWA) as Executing Agency, and the following lead agencies for each of the water system categories: the International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for transboundary aquifers including groundwater systems in small island developing states (SIDS); the International Lake Environment Committee Foundation (ILEC) for lake and reservoir basins; the UNEP-DHI Partnership – Centre on Water and Environment (UNEP-DHI) for river basins; and the Intergovernmental Oceanographic Commission (IOC) of UNESCO for large marine ecosystems (LMEs) and the open ocean.

The five water-category specific assessments cover 199 transboundary aquifers and groundwater systems in 43 small island developing states, 204 transboundary lakes and reservoirs, 286 transboundary river basins; 66 large marine ecosystems; and the open ocean, a total of 756 international water systems. The assessment results are organized into five technical reports and a sixth volume that provides a cross-category analysis of status and trends:

Volume 1 – ***Transboundary Aquifers and Groundwater Systems of Small Island Developing States: Status and Trends***
Volume 2 – ***Transboundary Lakes and Reservoirs: Status and Trends***
Volume 3 – ***Transboundary River Basins: Status and Trends***
Volume 4 – ***Large Marine Ecosystems: Status and Trends***
Volume 5 – ***The Open Ocean: Status and Trends***
Volume 6 – ***Transboundary Water Systems: Crosscutting Status and Trends***

A ***Summary for Policy Makers*** accompanies each volume.

Volume 6 presents a unique and first global overview of the contemporary risks that threaten international water systems in five transboundary water system categories, building on the detailed quantitative indicator-based assessment conducted for each water category. As a supplement to Volume 6, this global compendium of water system information sheets provides baseline relative risks at regional and system scales. The fact sheets are organized into 14 TWAP regions and presented as 12 annexes. Volume 6 and the compendium are published in collaboration among the five independent water-category based TWAP Assessment Teams under the leadership of the Cross-cutting Analysis Working Group, with support from the TWAP Project Coordinating Unit.

Transboundary Waters: A Global Compendium

The technical teams of the Transboundary Waters Assessment Programme(TWAP) assessed transboundary aquifers, lakes & reservoirs, river basins, and large marine ecosystems and prepared information (fact) sheets for water systems that were evaluated. Each fact sheet provides basic geomorphological information and presents baseline values of quantitative indicators that were used to establish relative risk levels. The water system fact sheets are organized into 14 TWAP regions that were used in the Crosscutting Analysis described in Volume 6. The regional compilations are presented as 11 annexes (A-K) of a global compendium, combining Southern & Southeastern Asia into one annex (I), and the Pacific Island Countries, Australia & Antarctica into another (Annex K). Each annex highlights contemporary regional risks as well as water system-specific risks. The annexes are:

- Annex A. Transboundary waters of Northern America
- Annex B. Transboundary waters of Central America & the Caribbean
- Annex C. Transboundary waters of Southern America
- Annex D. Transboundary waters of Eastern, Northern & Western Europe
- **Annex E. Transboundary waters of Eastern Europe**
- Annex F. Transboundary waters of Western & Middle Africa
- Annex G. Transboundary waters of Eastern & Southern Africa
- Annex H: Transboundary waters of Northern Africa & Western Asia
- Annex I: Transboundary waters of Southern & Southeastern Asia
- Annex J: Transboundary waters of Eastern & Central Asia
- Annex K: Transboundary waters of the Pacific Island Countries, Australia & Antarctica

In the case of the open ocean, which is the largest transboundary water system of planet earth, selected quantitative indicator maps prepared by the Open Ocean Assessment Team, are compiled in Annex L to highlight the contemporaneous state of the global ocean.

- Annex L: Selected indicator maps for the open ocean

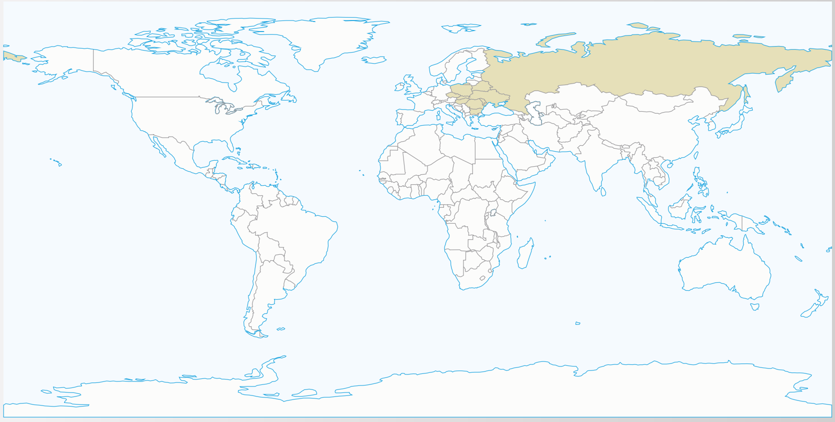
All information sheets and indicator maps for the open ocean may be downloaded individually from the following websites:

- Transboundary Aquifers: http://twapviewer.un-igrac.org
- Transboundary Lakes/ Reservoirs: http://ilec.lakes-sys.com/
- Transboundary River Basins: http://twap-rivers.org
- Large Marine Ecosystems: http://onesharedocean.org
- Open Ocean: http://onesharedocean.org

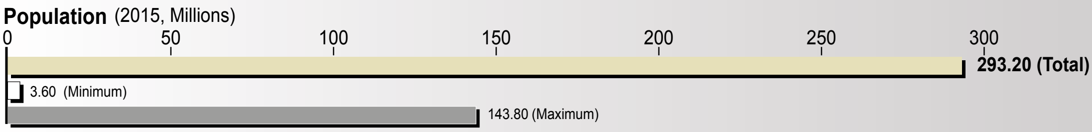
All TWAP publications are available for download at http://www.geftwap.org

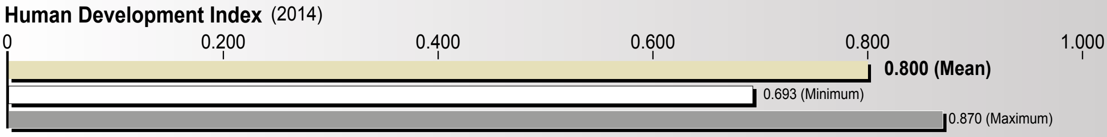
Over the long term, it is envisioned that these baseline information sheets will continue to be updated by future assessments at multiple spatial and temporal scales to better track the changing states of transboundary waters that are essential in sustaining human wellbeing and ecosystem health.

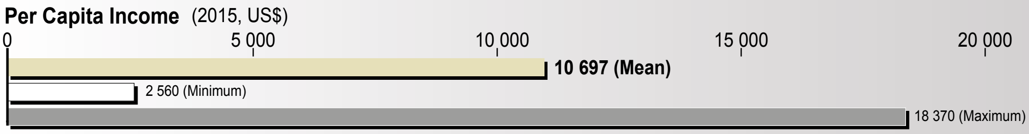
TRANSBOUNDARY WATERS: EASTERN EUROPE



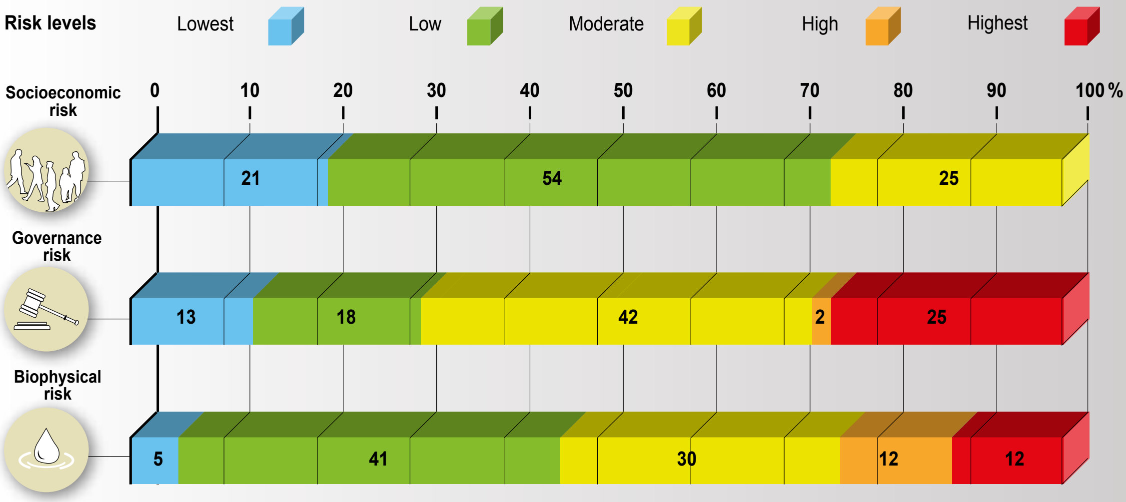
The region has an average Human Development Index of 0.863, belonging to the Very High HDI group with a total population of 449 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Pooling across 77 transboundary water systems in the region (bottom left), 44% of the water systems are at low socioeconomic risk, 36% at moderate governance risk, and 33% at moderate biophysical risks. On average (bottom right), the region's transboundary waters are at moderate socioeconomic, governance and biophysical risks. Aquifers, lakes, and LMEs are at moderate risk across risk themes, while river basins are threatened by low risk.



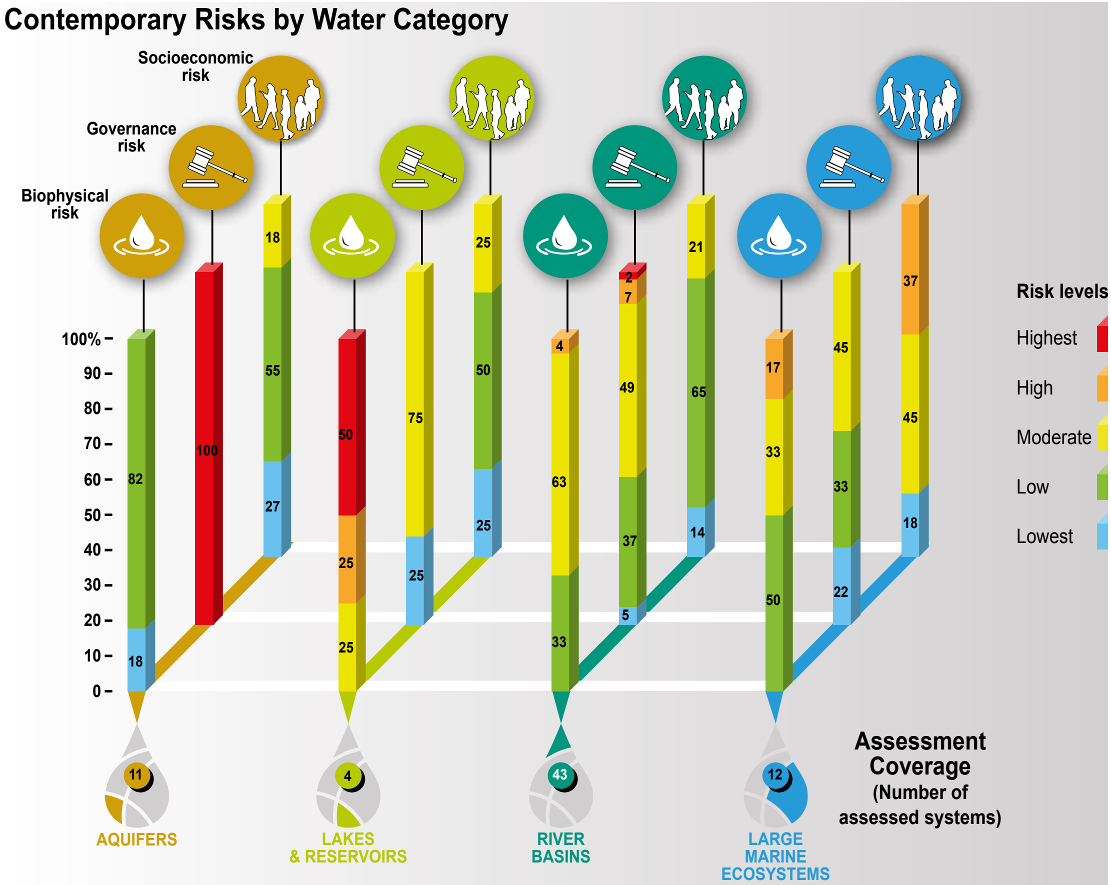


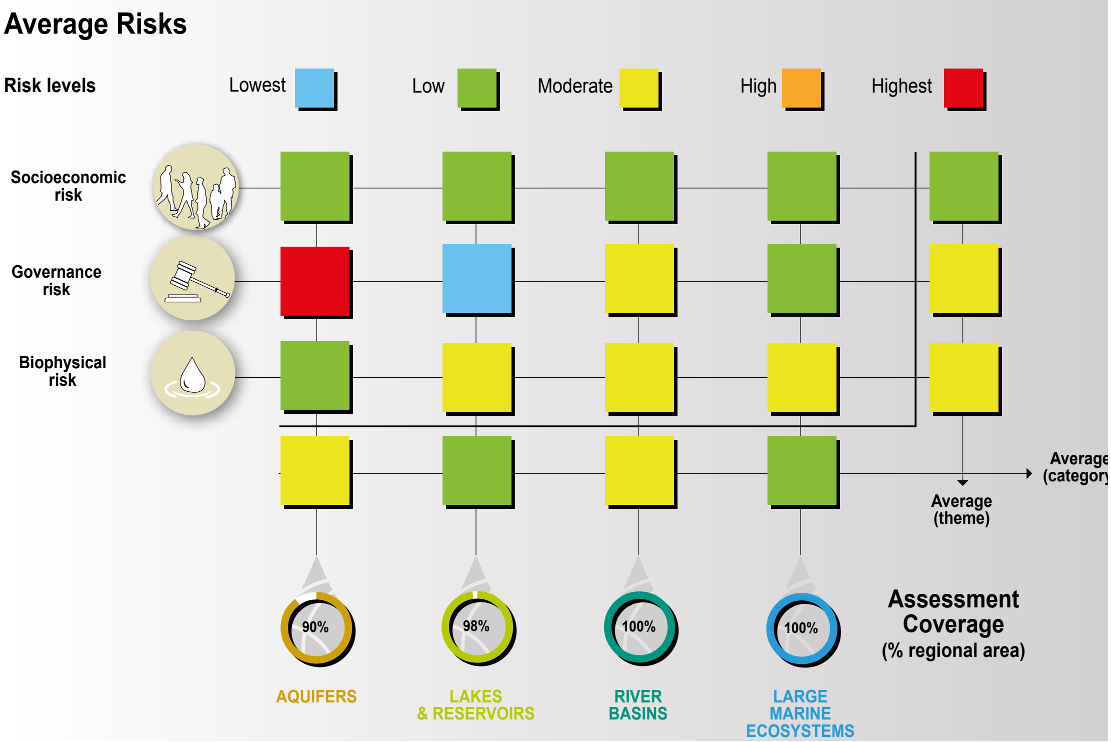


Contemporary Risks by Theme



Regional Risks by Water Category





1. Delger River
2. Irtysh-Obsky
3. Merged: 3A. Ordovician-Cambrian Groundwater Body
   3B. Cambrian-Vendian-Voronka Groundwater Body/ Lomonosovsky Aquifer
4. Middle Heilongjiang – Amur River Basin
5. Pre-Caspien
6. Shishhid River Aquifer
7. South-Pred-Ural
8. Syrt
9. Upper Pannonian Thermal Aquifer
10. Yenisei Upstream
11. Zeya River Basin

United Nations Educational, Scientific and Cultural Organization
International Hydrological Programme
International Groundwater Resources Assessment Centre
Goethe Universität Frankfurt am Main
Simon Fraser University Engaging the World

AS97 - Delger River

Geography

Total area TBA (km^2): 23 000

No. countries sharing: 2

Countries sharing: Mongolia, Russia

Population: 33 000

Climate Zone: Subarctic

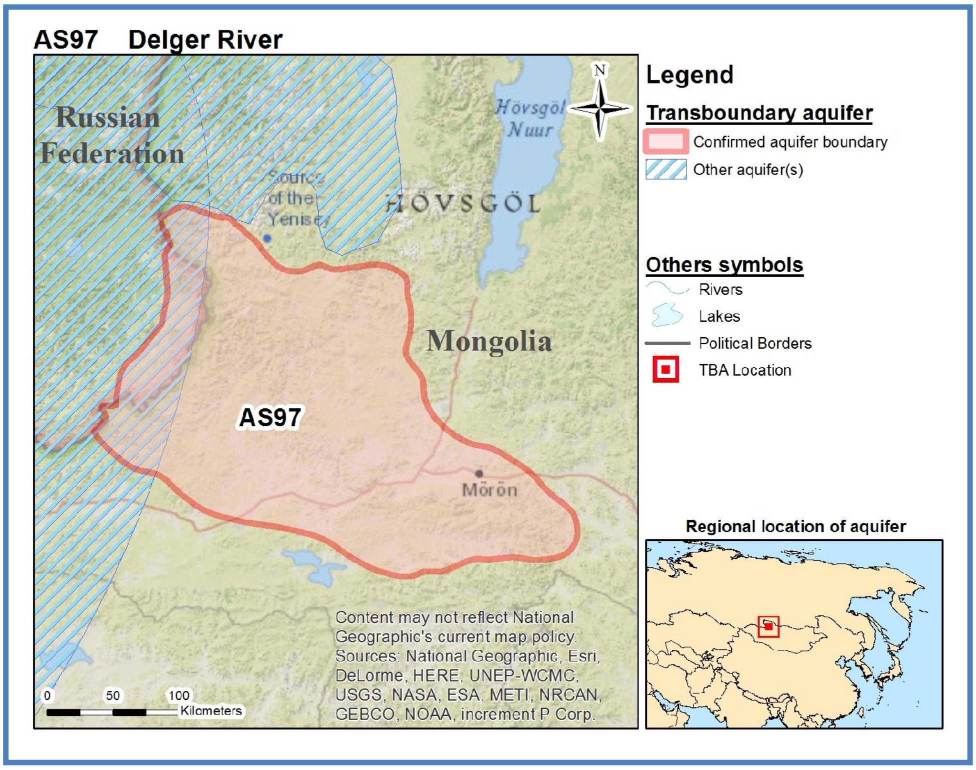
Rainfall (mm/yr): 280

Hydrogeology

Aquifer type: Multiple-layered hydraulically connected

Degree of confinement: Mostly unconfined, but some parts confined

Main Lithology: Data not available



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS97 - Delger River

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Mongolia	21	14000	100	100	0		2	<5	B	D
Russian Federation							1			
TBA level							**1**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Mongolia	21	15 000	-21	-32	67	80	26	80
Russian Federation	2	2000	-2	-5	48	47	0	80
TBA level	**20**	**15 000**	**-20**	**-31**	**66**	**77**	**26**	**80**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Mongolia	0	1	29	51	<1	0	1
Russian Federation	0	1	14	22	1	1	3
TBA level	**0**	**1**	**28**	**49**	**<1**	**0**	**1**

AS97 - Delger River

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Mongolia	19**	50**	104	Aquifer mostly unconfined, but some parts confined		High primary porosity fine/ medium sedimentary deposits	Secondary porosity: fractures	500
Russian Federation								
TBA level								

* Including aquitards/aquicludes

** These values would need revision, since a groundwater table higher than depth to top of the aquifer is un-realistic for an unconfined aquifer, although in this case the existence of some confined parts might imply a groundwater table higher than depth to top as an average.

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

As most of the information was provided by Mongolia, most of the values within this brief refer to the portion of the TBA within Mongolia.

Aquifer geometry

This aquifer is a multiple-layered hydraulically connected system with 2 main layers. The Aquifer is mostly unconfined, but some parts are confined. The average depth to the water table is 19 m within Mongolia, and the average depth to the top of the aquifer is 50 m while the average thickness of the aquifer system is 104 m.

Hydrogeological aspects

Information is not available on the predominant aquifer lithology. It however is characterised by a low primary porosity with secondary porosity: fractures. It furthermore has a low horizontal and vertical connectivity. The average transmissivity value is 500 m^2/d. The average recharge into the system is 435 Mm^3/yr and the aerial extent of the major recharge area is 18 900 km^2 (see appendix).

Linkages with other water systems

The predominant source of recharge is through precipitation over the aquifer area. The predominant discharge mechanism is through outflow into lakes.

Environmental aspects

None of the natural water quality is unfit for human consumption and furthermore no anthropogenic groundwater pollution has been identified. Around 29% of the aquifer within Mongolia is characterised by shallow groundwater whereas 27% of the aquifer area is covered with groundwater dependent ecosystems.

Socio-economic aspects

A total amount of 0.16 Mm^3 of groundwater was abstracted from the system during 2010 within Mongolia. The total amount of fresh water abstraction over the aquifer area was 4.50 Mm^3.

AS97 - Delger River

Legal and Institutional aspects
According to Mongolia a Bilateral Agreement with limited scope for TBA management has been signed by all parties but no Transboundary Institute has been established. The National institution is in place, but is not fully operational.

Emerging Issues
The total amount of stored groundwater and the recharge into the system needs to be reviewed.

Contributors to Global Inventory

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Considerations and recommendations

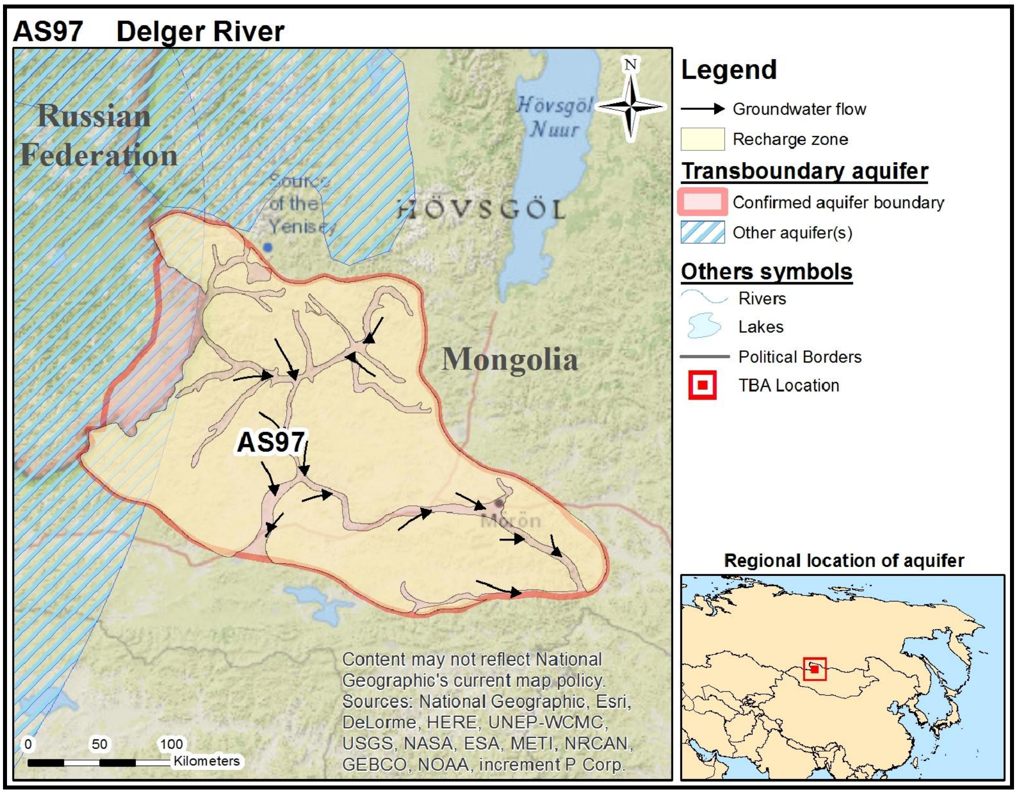
Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

One of the TBA countries contributed to the information. The information was adequate to describe the aquifer in general terms. Quantitative information was also available, and the indicators at the national level could also be calculated. The total groundwater volume within Mongolia needs to be reviewed.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

AS97 - Delger River

Appendix: AS97



TBA Map Showing Recharge Zones within the Delger River TBA

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

Request:
If you have additional data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

References:

- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.

AS97 - Delger River

- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: December 2015

AS150 – Irtysh-Obsky

Geography

Total area TBA (km^2): 906 000

No. countries sharing: 2

Countries sharing: Kazakhstan, Russian Federation

Population: 11 700 000

Climate Zone: Humid Continental

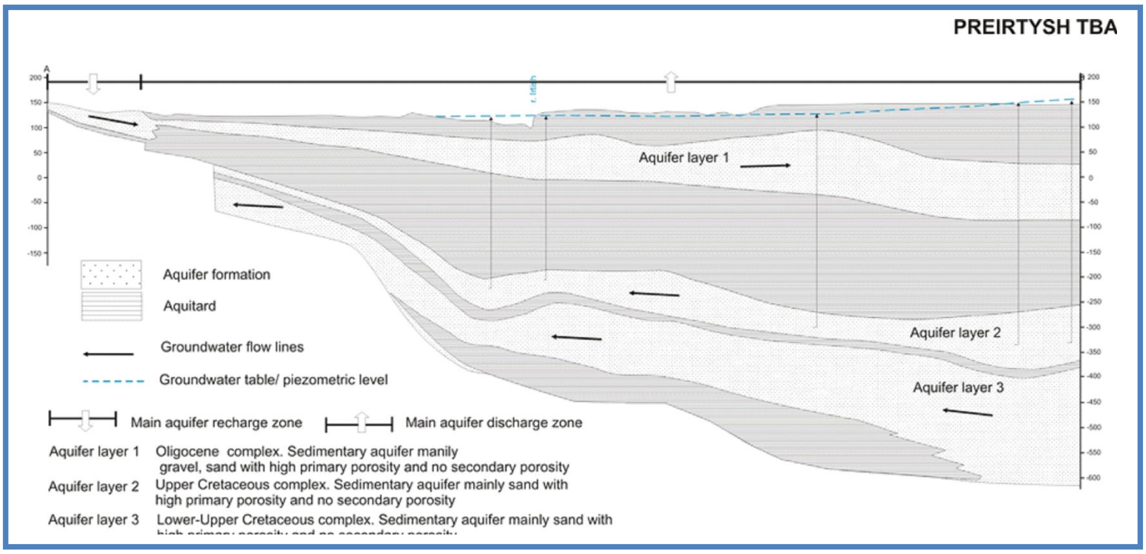
Rainfall: 390

Hydrogeology

Aquifer type: Multiple layers hydraulically connected

Degree of confinement: Mostly confined, but some parts unconfined

Main Lithology: Sediment - sand



Cross-section showing the 3 main aquifer layers (the part mainly within Kazakhstan)

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS150 – Irtysh-Obsky

TWAP Groundwater Indicators

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Kazakhstan	5	520					14	8	D	E
Russian Federation							11		D	E
TBA level							**13**		**D**	**E**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Primary Porosity	Secondary Porosity	Transmissivity (m^2/d)
Kazakhstan	<5	100	250	Aquifer mostly confined, but some parts unconfined	sediment – sand	High primary porosity fine/medium sedimentary deposits	No secondary porosity	750
Russian Federation	5	20	650	Aquifer mostly confined, but some parts unconfined	sediment – sand	High primary porosity fine/medium sedimentary deposits	No secondary porosity	
TBA level								

* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

AS150 – Irtysh-Obsky

Aquifer description

Aquifer geometry

This is a multiple layered hydraulically connected system that is 3-layered within Kazakhstan and a 4-layered within the Russian Federation. The aquifer is mostly confined but some parts are unconfined. The average depth to the water table is 5 m within Russia and <5 m within Kazakhstan. The average depth to the top of the aquifer varies from 20 m (Russia) to 100 m (Kazakhstan). The average thickness of the aquifer system varies from 250 m (Kazakhstan) to 650 m (Russia).

Hydrogeological aspects

The main aquifer lithology is sediment – sand, with sand and gravel in the upper Oligocene complex and mainly sand in the Upper-Cretaceous and the Lower-Cretaceous formations. All three horizons are characterised by a high primary porosity with no secondary porosity, and furthermore by a high horizontal and a low vertical connectivity. The average transmissivity value is 750 m^2/d (Kazakhstan). The average annual recharge, that is 100 % due to natural recharge processes, has been estimated as 1375 Mm^3/yr (Kazakhstan) and the total volume of groundwater within the system is 3424 km^3.

Linkages with other water systems

The predominant source of recharge is through precipitation on the aquifer area and runoff into the aquifer area from Russia. The predominant groundwater discharge mechanism is through river base flow (Russia), and through groundwater flow into surrounding aquifers (Kazakhstan). (see appendix)

Environmental aspects

Some of the natural groundwater quality is not fit for drinking water purposes and this is mainly due to elevated levels of natural salinity over a significant portion part of the aquifer but the data is not available to determine the percentage of the aquifer area that has been affected. No noticeable anthropogenic groundwater pollution has been identified to date over the aquifer area. No data is available with regard to the extent of shallow groundwater and groundwater dependent ecosystems over the aquifer area.

Socio-economic aspects

The annual amount of groundwater abstraction from the aquifer that was measured during 2010 was 242 Mm^3. No data is available with regard to the total amount of fresh water that was abstracted over the aquifer area for the same period.

Legal and Institutional aspects

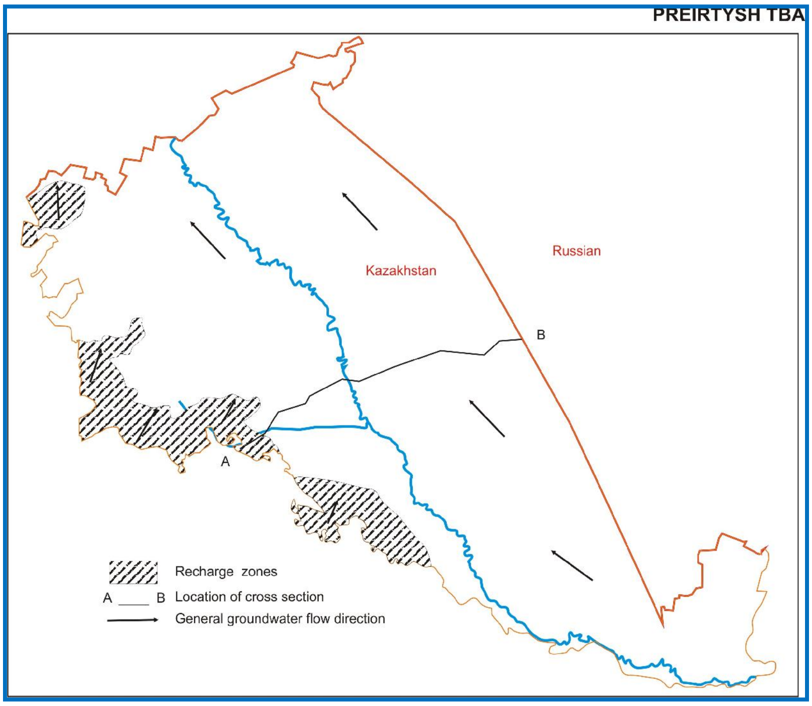
No Transboundary Agreement currently exists, nor is it currently under preparation. No Institution currently exists for TBA management.

Hot spot

This TBA is a high-yielding, fairly shallow, largely artesian groundwater resource. The aquifer is intensively exploited in Russia for water supply of large cities (Novosibirsk, Barnaul, etc.). According to groundwater monitoring data in the Russian Federation, the groundwater cone of depression as a result of these abstractions has grown to more than 50 000 km^2 and has spread to the territory of Kazakhstan. A joint investigation regarding the exploitable resources of this major transboundary groundwater resource needs to be urgently carried out. A Bi-lateral Agreement for its joint operation and sustainable development is essential.

AS150 – Irtysh-Obsky

Appendix: AS75



Preirtysh: Groundwater recharge zones

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Abdelkader Dodo	Observatoire du Sahara et du Sahel	Tunisia	abdelkader.dodo@oss.org.tn	Regional coordinator
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Oleg Podolny	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	podolnyo@mail.ru	Lead National Expert
Boris Korolev	Federal state unitary geological organization "Hydrospecialgeology"	Russia	korolyev@mail.ru	Contributing national expert

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Both TBA countries have contributed to the information. Some quantitative information was also available, and some of the indicators could be calculated.

AS150 – Irtysh-Obsky

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

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References:

- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: October 2015

EU 108 – Ordovician-Cambrian Groundwater Body

Geography

Total area TBA (km^2): 81 000

No. countries sharing: 2

Countries sharing: Estonia, Russian Federation

Population: 1 900 000

Climate zone: Humid Continental

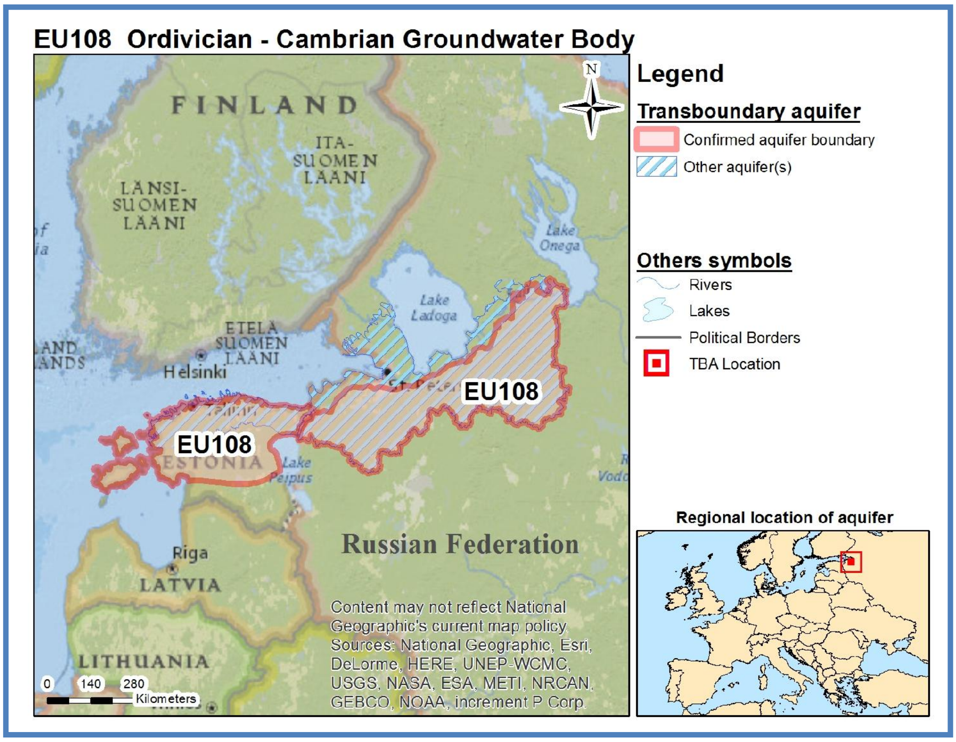
Rainfall (mm/yr): 660

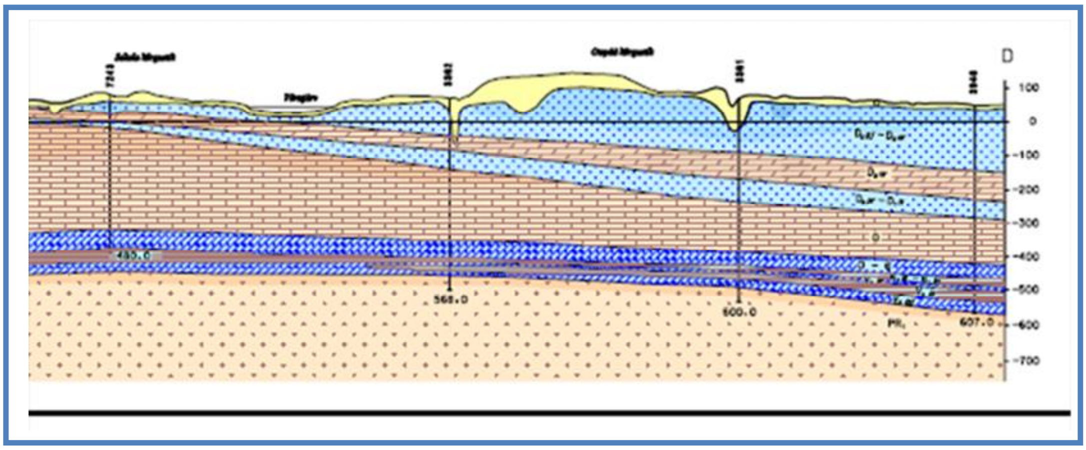
Hydrogeology

Aquifer type: Multiple layers hydraulically connected

Degree of confinement: Confined

Main Lithology: Sedimentary rocks - sandstones





Simplified cross-section: Ordovician Cambrian aquifer (in light blue)

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate.

EU 108 – Ordovician-Cambrian Groundwater Body

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Estonia	1	20	100			A	31	50		A
Russian Federation					0		19		B	D
TBA Level							**23**			**F**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Primary Porosity	Secondary Porosity	Transmissivity (m^2/d)
Estonia	48	130	33	Whole aquifer confined	Sedimentary rocks - Sandstone	Low primary porosity intergranular porosity	No secondary porosity	35
Russian Federation	28**	13**	130	Whole aquifer confined	Sedimentary rocks - Shale	High primary porosity fine/ medium sedimentary deposits	Secondary porosity: Fractures	
TBA Level								

* Including aquitards/aquicludes
** These values would need revision, since a groundwater table lower than depth to top of the aquifer is un-realistic for a confined aquifer.
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

EU 108 – Ordovician-Cambrian Groundwater Body

Aquifer description

Aquifer geometry

This is a confined aquifer system constituted by multiple layers that are hydraulically connected. The average depth to the water table varies between 28m and 48m. The average depth to the top of the aquifer varies between 13m and 130m. The average thickness of the aquifer ranges between 30m and 130m in Estonia and Russia respectively.

Hydrogeological aspects

The aquifer is composed of sandstones, with inter-granular as well secondary porosity due to dissolution and fissured sandstone. The average transmissivity is 35m^2/day within Estonia. The average amount of recharge, which is all due to natural recharge, within the Estonia portion (see Appendix) is 20 Mm^3/annum.

Linkages with other water systems

Recharge is from the overlying aquifer through leakage, and discharge is produced to other connected aquifers. There is no interaction with surface waters. Groundwater flow direction is from Russia to SW Estonia.

Environmental aspects

Besides the presence of some natural salinity that has been reported by Russia, the natural water quality is generally suitable for human consumption. Some local pollution from metals, industrial waste disposal and fertilizers has been reported within the Russia side, but no groundwater pollution has been observed within Estonia. No shallow groundwater or groundwater dependent ecosystems have been recorded within the aquifer area.

Socio-economic aspects

The total amount of groundwater that was abstracted from the aquifer during 2010 was 96 Mm^3, 90% of it in Russia. The type of use was only recorded for Estonia - water supply, industry and a minor consumption for agriculture. The total fresh water abstraction within the aquifer area has not been reported for either country.

Legal and Institutional aspects

A ratified agreement exists for Estonia-Russia TBA management, that was signed during 1995 and a new agreement is in preparation (Estonia). A dedicated Transboundary Institution exists on the Estonian side. Local management is under the National legislation and regulations.

Priority issues

The main pressure on the TBA is the groundwater abstraction taking place in both countries. The most important threat to the confined aquifer with limited recharge is declining piezometric levels as a result of aquifer exploitation.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Lucila Candela	Universidad Politécnica de Catalunya	Spain	Lucila.Candela@upc.edu	Regional coordinator
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Heddy Klasen	Ministry of the Environment	Estonia	heddy.klasen@envir.ee	Lead National Expert

EU 108 – Ordovician-Cambrian Groundwater Body

Name	Organisation	Country	E-mail	Role
Boris Korolev	Federal state unitary geological organization "Hydrospecialgeology"	Russia	korolyev@mail.ru	Contributing national expert

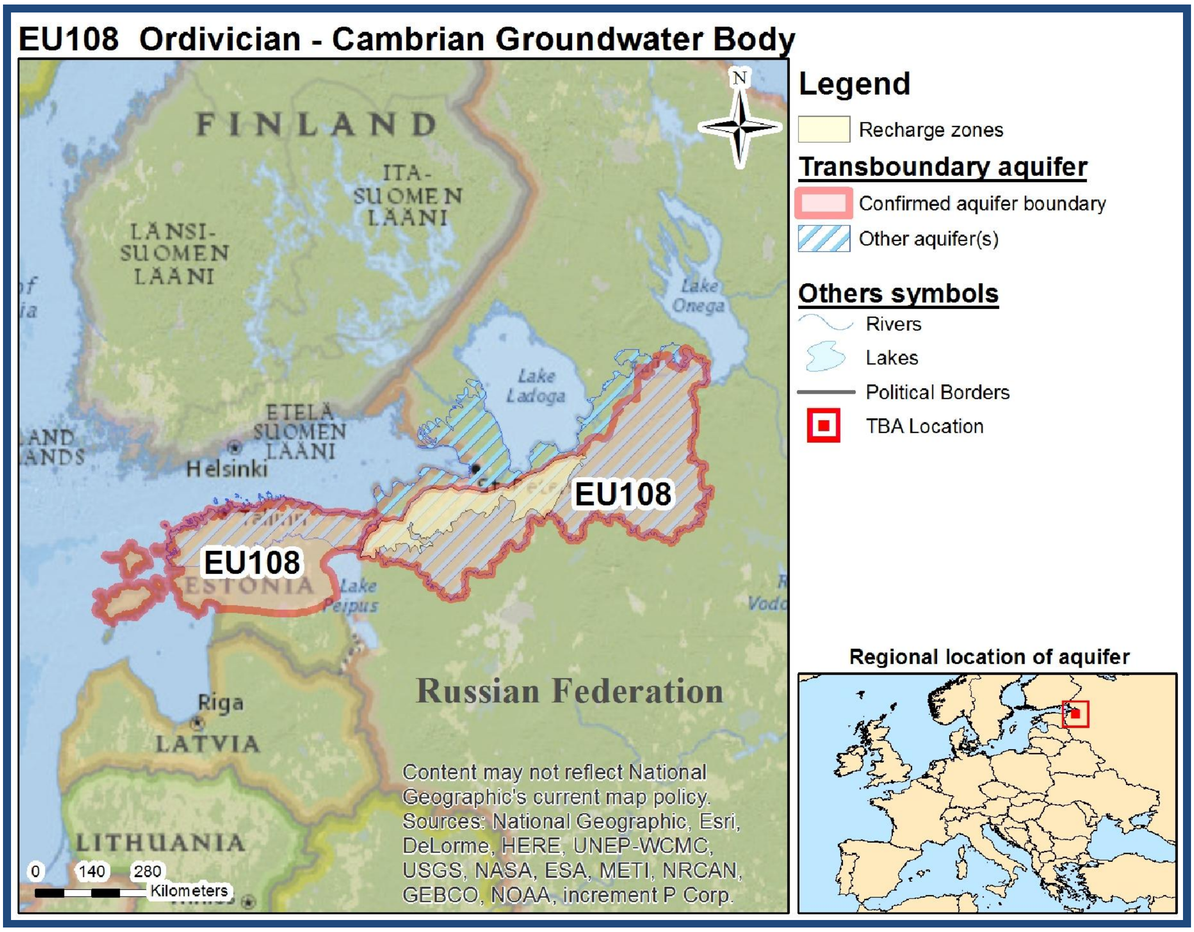
Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Both TBA countries provided information that allowed description of the system, but it was not enough to calculate the groundwater indicators for the transboundary system.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Appendix: EU 108



Map showing Recharge zones within the Ordovician-Cambrian Groundwater Body

EU 108 – Ordovician-Cambrian Groundwater Body

Colophon

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- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
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- All other data: TWAP Groundwater (2015).

Version: December 2015

EU109 – Cambrian-Vendian-Voronka Groundwater Body / Lomonosovsky Aquifer

Geography

Total area TBA (km^2): 79 000

No. countries sharing: 2

Countries sharing: Estonia, Russian Federation

Population: 3 500 000

Climate zone: Humid Continental

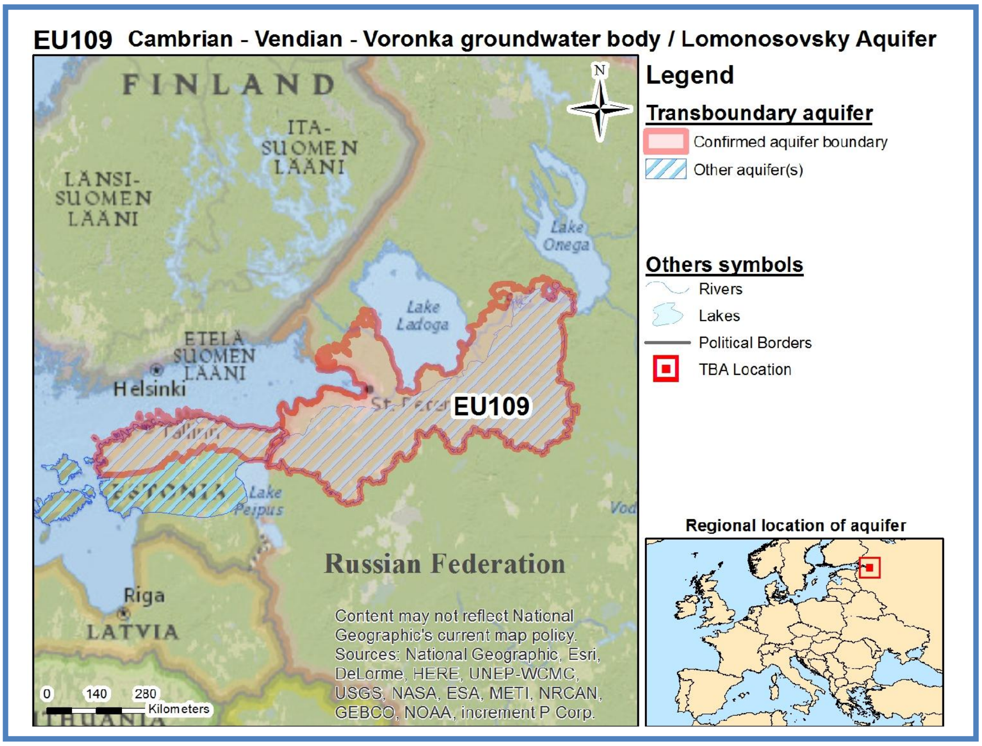
Rainfall (mm/yr): 670

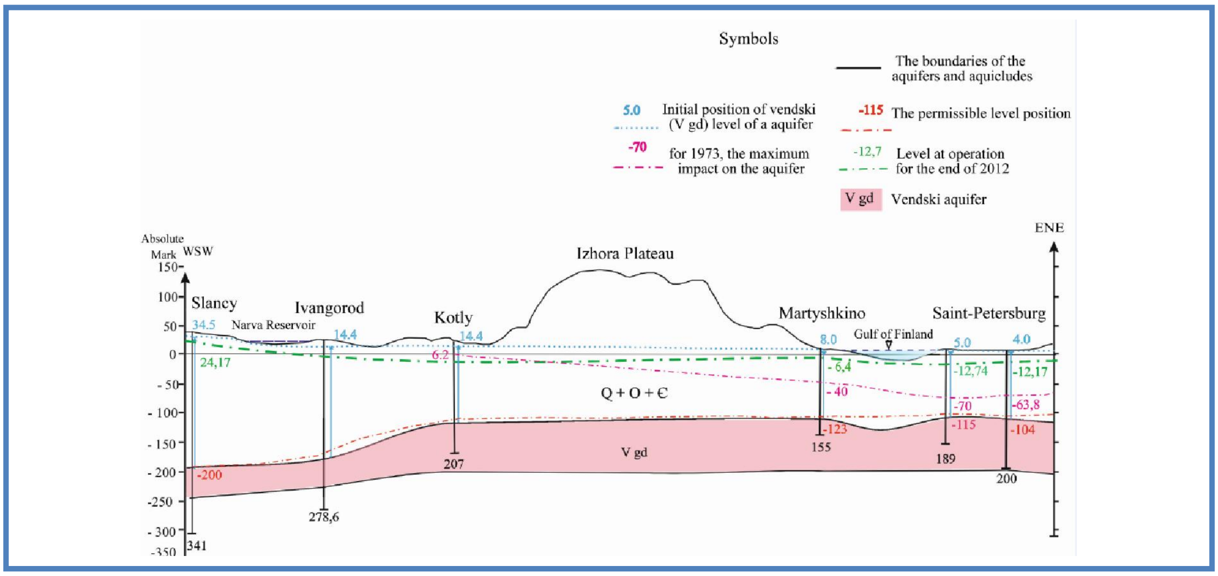
Hydrogeology

Aquifer type: Single layered

Degree of confinement: Confined

Main Lithology: Sedimentary rocks - sandstone





Cross-section of the aquifer showing the Initial water level and the impact on the aquifer

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate.

EU109 – Cambrian-Vendian-Voronka Groundwater Body / Lomonosovsky Aquifer

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Estonia	1	9	100			A	51	50		A
Russian Federation					0		42		B	D
TBA Level							**45**		**E**	**F**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Primary Porosity	Secondary Porosity	Transmissivity (m^2/d)
Estonia	48	130	37	Whole aquifer confined	Sedimentary rocks - Sandstone	Low primary porosity intergranular porosity	No secondary porosity	90
Russian Federation	30	200	60	Whole aquifer confined	Sedimentary rocks - Shale	High primary porosity fine/ medium sedimentary deposits	Secondary porosity: Fractures	
TBA level								

* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

EU109 – Cambrian-Vendian-Voronka Groundwater Body / Lomonosovsky Aquifer

Aquifer description

Aquifer geometry
This is a single-layered confined aquifer system, shared by Estonia and the Russian Federation. The average depth to the water table varies between 30m and 48m and the average depth to the top of the aquifer varies between 130m and 200m. The average thickness of the aquifer system varies between 37m and 60m. See Appendix 1 for a cross-section.

Hydrogeological aspects
The aquifer system is composed of sandstones. Groundwater flow is from the Russian border to Estonia (E-W). It has a low to high primary porosity with some secondary porosity: fractures in parts. Furthermore it has a low to high horizontal connectivity and a low vertical connectivity. The average annual recharge, which is 100% due to natural conditions, on the Estonia part of the aquifer is 6.1Mm^3/annum. Recharge on the Russia portion of the aquifer occurs over an area of 11 000 km^2 (see Appendix 2). There appears to be no groundwater depletion in this shared aquifer system, although groundwater level lowering has been observed in the underlying Vendian hydro-stratigraphic unit aquifer (see Appendix 1), with a cone of depression 60 m deep in the Leningrad region.

Linkages with other water systems
Recharge to aquifer occurs through an overlying leaky aquitard or from leakage through a buried valley filled by Quaternary deposits on the Estonian side and from precipitation on the Russian side. Discharge is produced to boundary aquifers.

Environmental aspects
Groundwater exploitation is limited due to the natural salinity of the aquifer on the Estonian side. No specific data on groundwater use has been provided by Russia. Within Estonia no anthropogenic pollution has been detected although there is some groundwater pollution within the Russia part of the aquifer but the amount has not been quantified. No shallow groundwater or groundwater dependent ecosystems have been recorded.

Socio-economic aspects
The total groundwater annual abstraction from the system during 2010 was 15 Mm^3. The total amount of fresh water that was abstracted over the aquifer area during the same period was not recorded.

Legal and Institutional aspects
A Ratified Agreement for TBA management by Estonia-Russia has been signed (1995) and a new Agreement is in preparation (Estonia). Local management takes place under National legislation and regulations.

Priority issues
Groundwater abstraction may constitute a transboundary threat which needs to be assessed with further data.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Lucila Candela	Universidad Politécnica de Catalunya	Spain	Lucila.Candela@upc.edu	Regional coordinator
Rein Perens	Geological Survey of Estonia	Estonia	perens@egk.ee	Contributing national expert

EU109 – Cambrian-Vendian-Voronka Groundwater Body / Lomonosovsky Aquifer

Name	Organisation	Country	E-mail	Role
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Heddy Klasen	Ministry of the Environment	Estonia	heddy.klasen@envir.ee	Lead National Expert
Boris Korolev	Federal state unitary geological organization "Hydrospecialgeology"	Russia	korolyev@mail.ru	Contributing national expert

Considerations and recommendations

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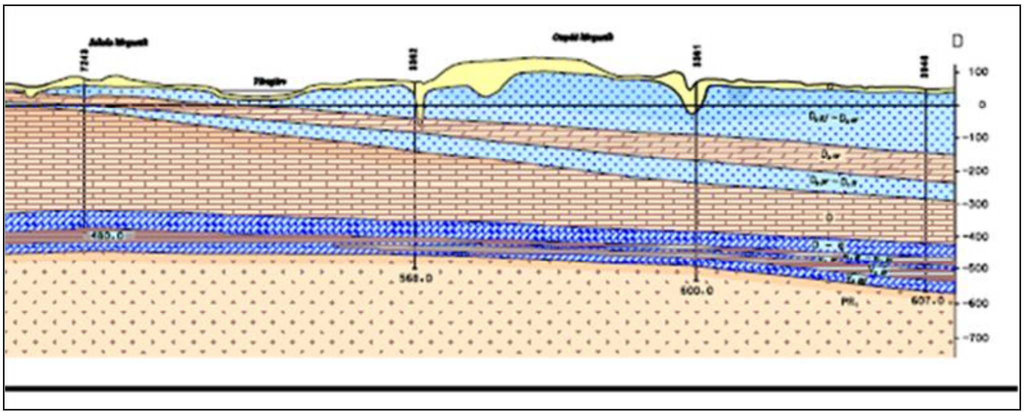
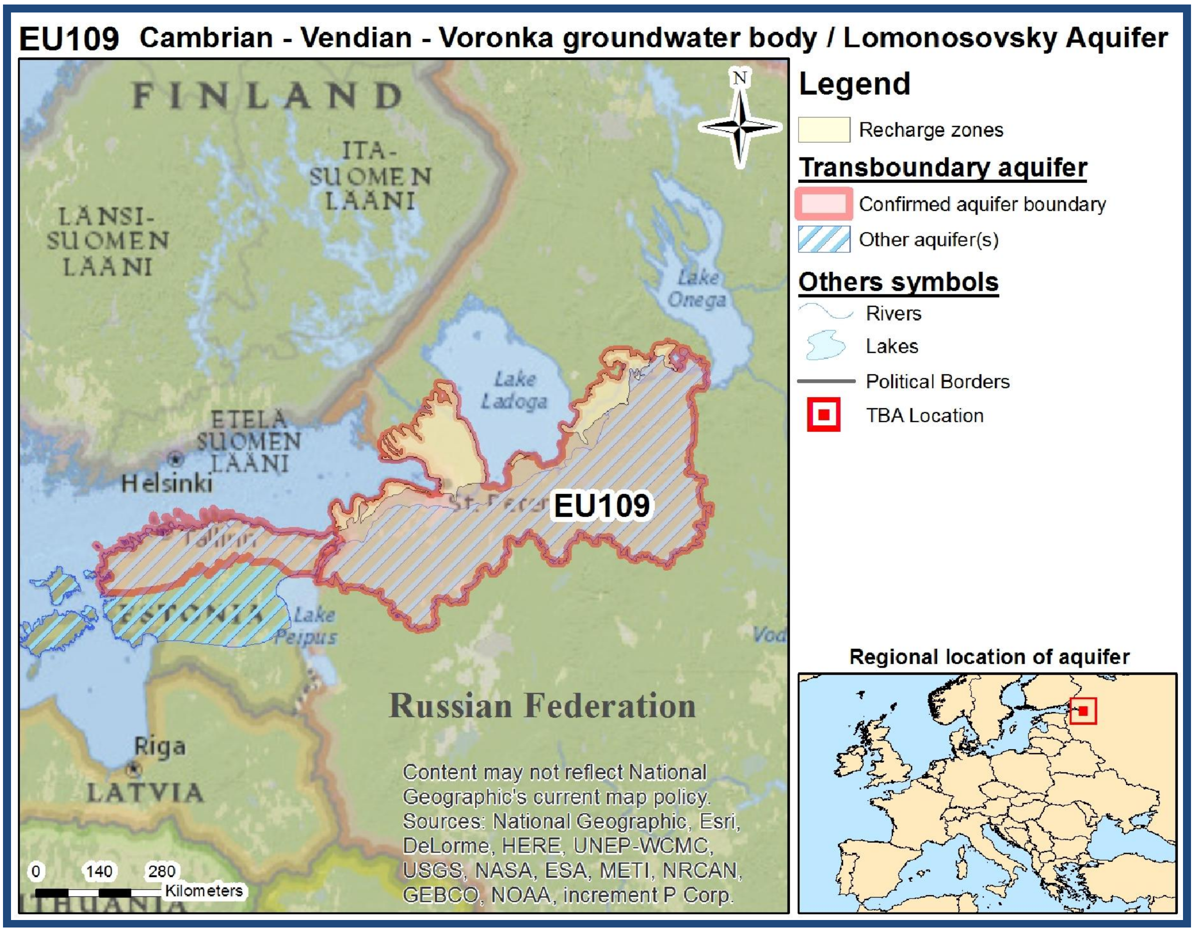
Appendix 1: EU109:



Part of a cross-section - Dark blue: Cambrian Vendian Voronka aquifer

EU109 – Cambrian-Vendian-Voronka Groundwater Body / Lomonosovsky Aquifer

Appendix 2: EU109



Map showing Recharge zones within the Aquifer system

Colophon

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Request:
If you have additional data or information about this transboundary aquifer that can improve the quality of this information

EU109 – Cambrian-Vendian-Voronka Groundwater Body / Lomonosovsky Aquifer

sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

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- All other data: TWAP Groundwater (2015).

Version: December 2015

AS87 - Middle Heilongjiang - Amur River Basin

Geography

Total area TBA (km^2): 110 000

No. countries sharing: 2

Countries sharing: China, Russian Federation

Population: 3 500 000

Climate Zone: Humid Continental

Rainfall (mm/yr): 640

Hydrogeology

Aquifer type: Data not available

Degree of confinement: Data not available

Main Lithology: Data not available

No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS87 - Middle Heilongjiang - Amur River Basin

TWAP Groundwater Indicators from Global Inventory

No data available.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita: Current state (m^3/y/capita)	Renewable groundwater per capita: Projection 2030 (% change to current state)	Renewable groundwater per capita: Projection 2050 (% change to current state)	Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
China	97	1600	4	17	48	41	51	24
Russian Federation	170	16 000	10	24	30	33	34	25
TBA level	**140**	**5100**	**4**	**17**	**45**	**37**	**51**	**25**

	Groundwater depletion (mm/y)	Population density: Current state (Persons/km2)	Population density: Projection 2030 (% change to current state)	Population density: Projection 2050 (% change to current state)	Groundwater development stress: Current state (%)	Groundwater development stress: Projection 2030 (% point change to current state)	Groundwater development stress: Projection 2050 (% point change to current state)
China	-1	59	3	-7	12	2	4
Russian Federation	-1	11	-4	-14	<1	0	0
TBA level	**-1**	**28**	**1**	**-8**	**3**	**1**	**1**

Key parameters table from Global Inventory

No data available.

Aquifer description

No data available.

Contributors to Global Inventory

No contributions.

Considerations and recommendations

Request:
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Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199

AS87 - Middle Heilongjiang - Amur River Basin

transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

References:

- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: October 2015

AS19 - Pre-Caspien

Geography

Total area TBA (km^2): 180 000

No. countries sharing: 2

Countries sharing: Azerbaijan, Iran

Population: 1 700 000

Climate Zone: Semi-arid

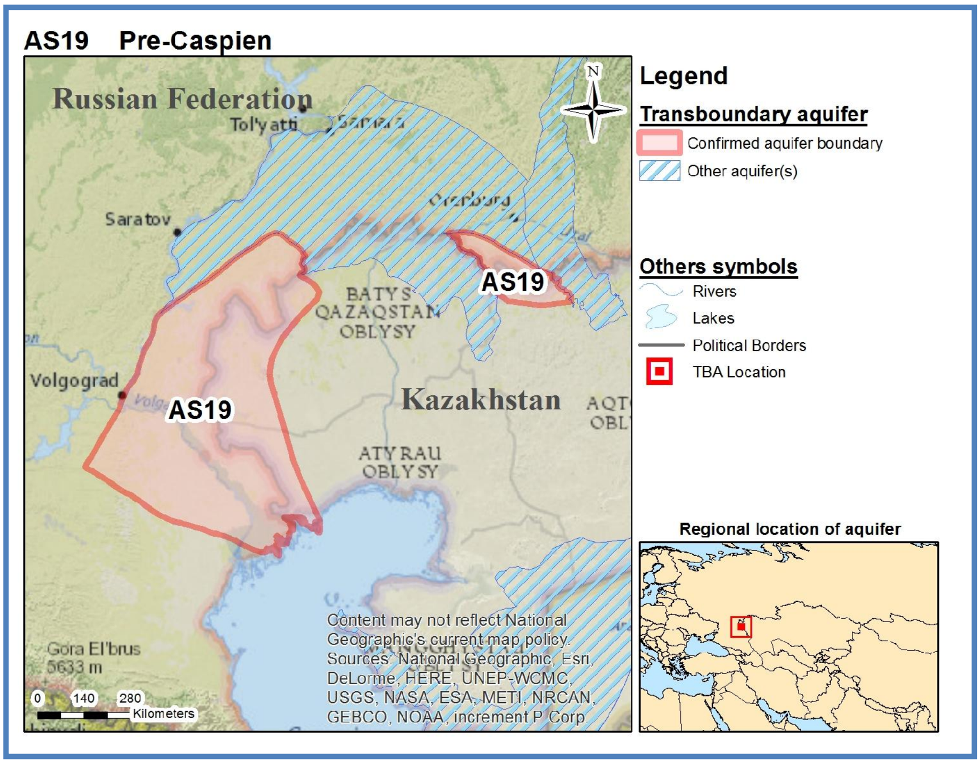
Rainfall (mm/yr): 290

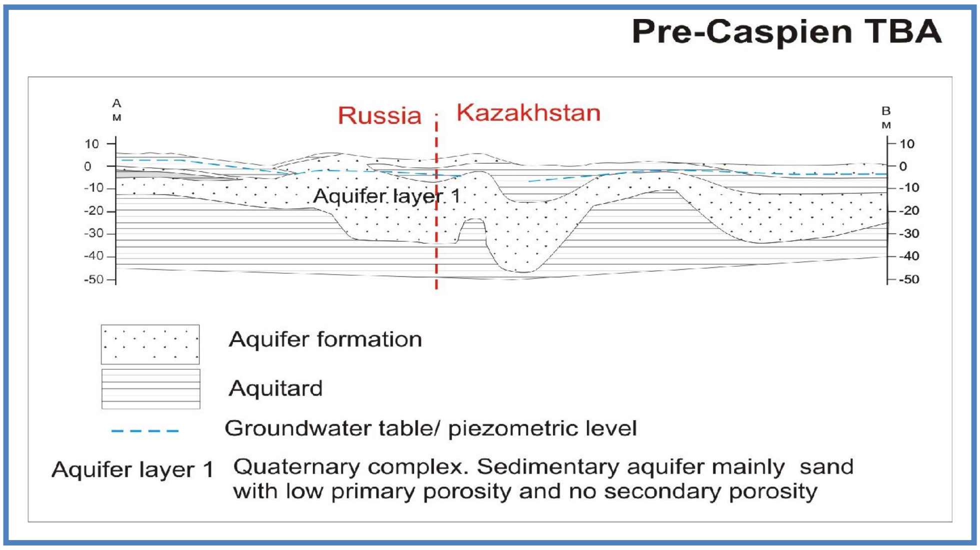
Hydrogeology

Aquifer type: Single-layered

Degree of confinement: Mostly semi-confined, but with some parts unconfined.

Main Lithology: Sediment – sand and sedimentary rocks – sandstones





Cross-section over part of the Transboundary Aquifer

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS19 - Pre-Caspien

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Kazakhstan			5		0		2		D	E
Russian Federation			5		0		12		D	E
TBA level			**5**		**0**		**10**		**D**	**E**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).

(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.

(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).

(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.

(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).

(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Kazakhstan	26	9900	-5	-7	17	30	11	35
Russian Federation	200	16 000	7	19	11	13	12	6
TBA level	**150**	**16 000**	**6**	**16**	**11**	**14**	**12**	**6**

AS19 - Pre-Caspien

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Kazakhstan	0	3	11	17	1	0	0
Russian Federation	0	12	-6	-14	<1	0	0
TBA level	**0**	**9**	**-4**	**-12**	<1	**0**	**0**

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Kazakhstan	5	10	20	Aquifer mostly semi-confined, but some parts unconfined	Sediment - Sand	Low Primary porosity intergranular porosity	No Secondary porosity	200
Russian Federation	10	10	25	Aquifer mostly semi-confined, but some parts unconfined	Sediment - Sand	High Primary porosity fine/ medium sedimentary deposits	No Secondary porosity	
TBA level								

* Including aquitards/aquicludes
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

Aquifer geometry

This is a single-layered aquifer in both countries. The average depth to the water table varies between 5 and 10m. The average depth to the top of the aquifer is 10m and the thickness of the entire aquifer system varies between 20m and 25m. The aquifer is mostly semi-confined, but with some parts unconfined.

Hydrogeological aspects

The predominant lithology is Sediment – sand. It has a low to high primary porosity with no secondary porosity and a low horizontal connectivity. The average transmissivity is around 200m^2/day in both countries. Recharge into the system is 100% through natural recharge.

Linkages with other water systems

Precipitation on the aquifer area is the predominant source of recharge and evapotranspiration and river base flow the predominant groundwater discharge mechanism.

AS19 - Pre-Caspien

Environmental aspects

In both countries groundwater is not suitable for human consumption in over 95% of the aquifer area on the superficial layers as a result of elevated natural salinity. Very little to no pollution has been identified. No information on shallow groundwater or on groundwater dependent ecosystems has been recorded.

Socio-economic aspects

The mean annual groundwater abstraction in Russia is 0.5 Mm^3/annum and 0 in Kazakhstan. No groundwater depletion is occurring. The total amount of fresh water abstraction over the aquifer area has not been recorded.

Legal and Institutional aspects

No Transboundary Agreement is in place. Although it is reported that in both countries there is no National Institution in place with the appropriate mandate, groundwater abstraction, groundwater quality protection, and drilling control are done according to law/ regulations, and measures are also applied in practice.

Emerging Issues

No significant groundwater abstraction is occurring near the border. Once the Koyandy well-field in Kazakhstan near the Russian border comes into operation, appropriate joint monitoring of the aquifer system becomes a priority.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Dmitrii Plaksin		Kyrgyzstan	plaksind@ya.ru	Regional coordinator
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Aleksandr Kuchin	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	agkuchin@gmail.com	Contributing national expert
Oleg Podolny	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	podolnyo@mail.ru	Lead National Expert
Boris Korolev	Federal state unitary geological organization "Hydrospecialgeology"	Russia	korolyev@mail.ru	Contributing national expert

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Both countries have provided data to describe the aquifer adequately, but there was not enough numerical information to allow calculation of groundwater indicators at the transboundary level.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

AS19 - Pre-Caspien

Colophon

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References:

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- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: December 2015

UNEP gef United Nations Educational, Scientific and Cultural Organization International Hydrological Programme igrac International Groundwater Resources Assessment Centre

AS96 - Shishhid River Aquifer

Geography

Total area TBA (km^2): 23 000

No. countries sharing: 2

Countries sharing: Mongolia, Russia

Population: 21 000

Climate Zone: Subarctic

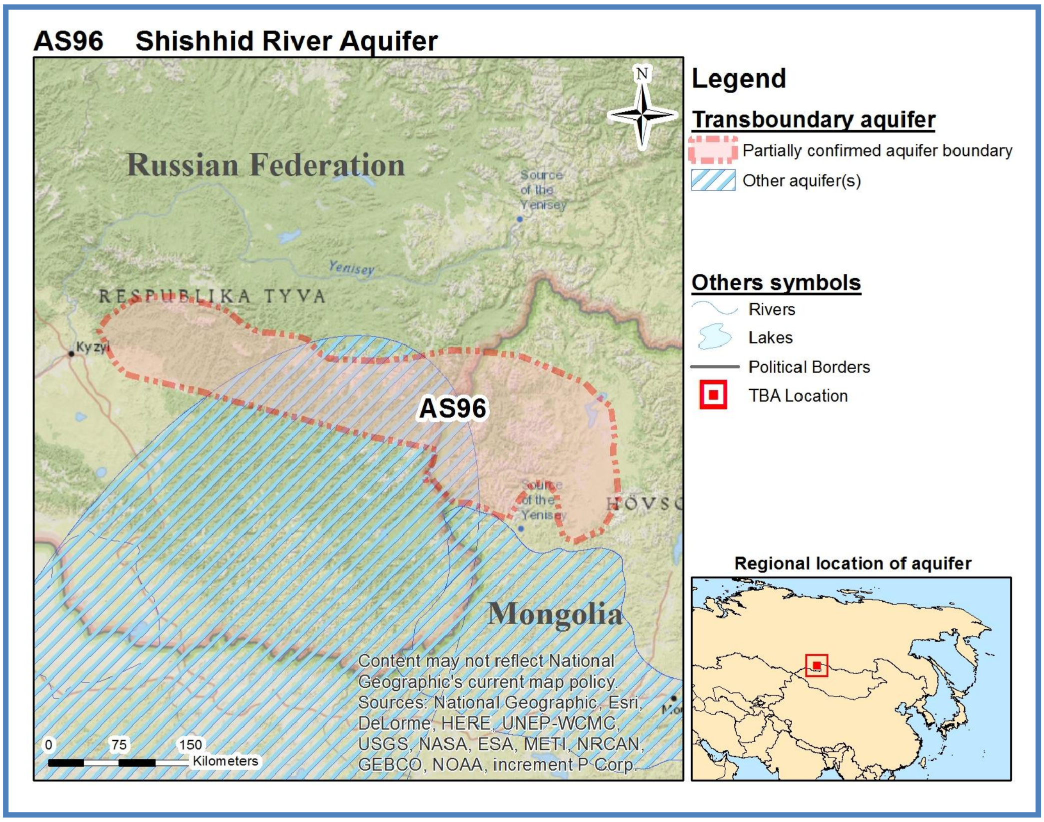
Rainfall (mm/yr): 380

Hydrogeology

Aquifer type: Single layered system

Degree of confinement: Entire aquifer is unconfined

Main Lithology: Sediment - gravel



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS96 - Shishhid River Aquifer

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Mongolia	210	150000	70	45			1	<5	B	D
Russian Federation							1			
TBA level							**1**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).

(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.

(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).

(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.

(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).

(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Mongolia	5	3400	-15	-25	74	73	0	80
Russian Federation	16	23 000	22	39	20	20	18	80
TBA level	**11**	**11 000**	**-1**	**-4**	**38**	**38**	**18**	**80**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Mongolia	0	1	28	49	1	1	3
Russian Federation	0	1	-4	-11	<1	0	0
TBA level	**0**	**1**	**16**	**26**	**<1**	**0**	**1**

AS96 - Shishhid River Aquifer

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Mongolia	<5	<5	37	Whole aquifer unconfined	Sediment - Gravel	Low primary porosity intergranular porosity	No secondary porosity	32
Russian Federation								
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

As most of the information was provided by Mongolia, most of the values within this brief refer to the portion of the TBA within Mongolia.

Aquifer geometry

This aquifer is a single-layered system and the entire aquifer is unconfined. The average depth to the water table is <5 m, and the average depth to the top of the aquifer is also <5 m while the average thickness of the aquifer system is 37 m.

Hydrogeological aspects

The predominant aquifer lithology is sediment - gravel that has a low inter-granular primary porosity with no secondary porosity. It furthermore has a high horizontal and vertical connectivity. The average transmissivity value is 32 m^2/d. The average recharge into the system also needs to be reviewed and the aerial extent of the major recharge area is over 20 100 km^2 (see appendix).

Linkages with other water systems

The predominant source of recharge is through precipitation over the aquifer area. The predominant discharge mechanism is through river base flow.

Environmental aspects

A total amount of 30% of the natural groundwater quality is unfit for human consumption over a significant part of the aquifer due mainly to natural salinity and the extreme hardness of the water. Furthermore no anthropogenic groundwater pollution over the aquifer area has been identified. Around 15% of the aquifer within Mongolia is characterised by shallow groundwater whereas 5% of the aquifer area is covered by groundwater dependent ecosystems.

Socio-economic aspects

A total amount of 0.30 Mm^3 of groundwater was abstracted from the system during 2010 within Mongolia. The total amount of fresh water abstraction over the aquifer area was 0.68 Mm^3.

Legal and Institutional aspects

According to Mongolia a Bi-lateral Agreement with limited scope for TBA management signed by all parties does exists. Furthermore the National institution is in place, but it is not fully operational.

Emerging Issues

Joint monitoring work would be a good platform for future cooperation.

AS96 - Shishhid River Aquifer

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Sangam Shresta	Asian Institute of Technology	Thailand	sangamshrestha@gmail.com	Regional coordinator
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Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

One of the TBA countries contributed to the information. The information was adequate to describe the aquifer in general terms. Some quantitative information was also available, and most of the indicators at the national level could also be calculated. The total groundwater volume within Mongolia needs to be reviewed. The average recharge into the system also needs to be reviewed.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Appendix: AS96 –

Showing Recharge zones of the Shishhid River Aquifer within Mongolia

AS96 - Shishhid River Aquifer

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- All other data: TWAP Groundwater (2015).

Version: October 2015

AS31 - South-Pred-Ural

Geography

Total area TBA (km^2): 88 000

No. countries sharing: 2

Countries sharing: Kazakhstan, Russian Federation

Population: 1 800 000

Climate Zone: Subartic

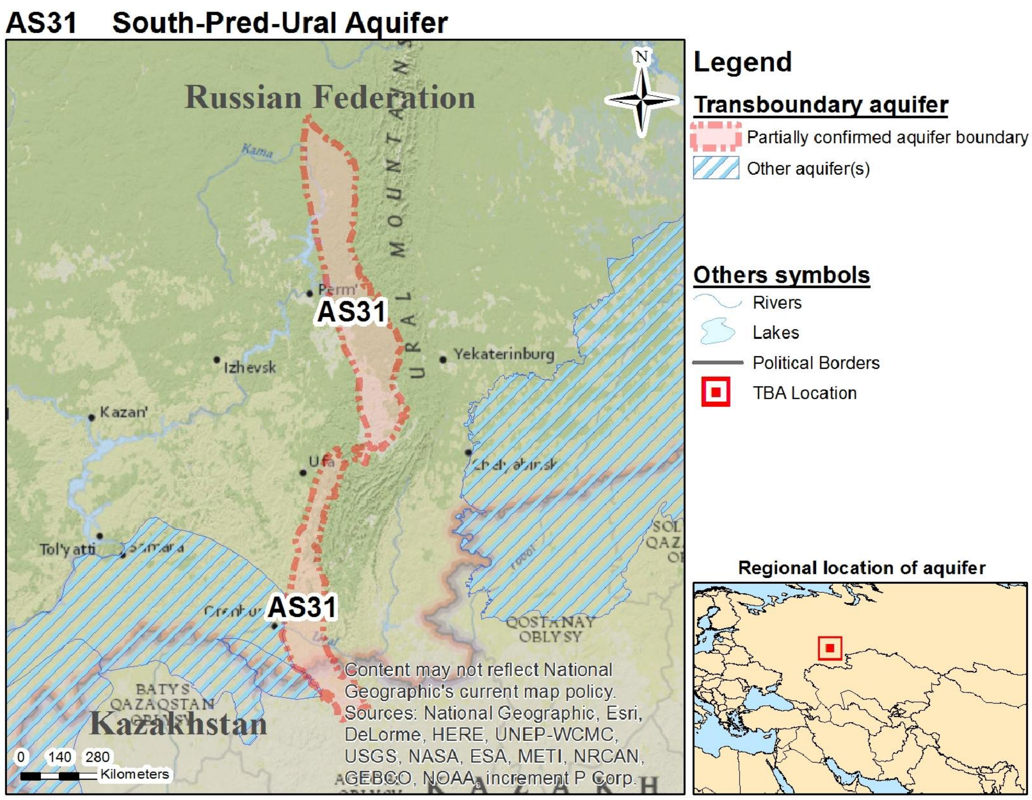
Rainfall (mm/yr): 540

Hydrogeology

Aquifer type: Multiple-layered hydraulically connected

Degree of confinement: Mostly confined, but some parts unconfined

Main Lithology: Sediments - sands and sedimentary rocks - sandstone



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS31 - South-Pred-Ural

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Kazakhstan	30	980			0		31	10	D	E
Russian Federation					0		19		D	E
TBA level					**0**		**21**		**D**	**E**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).

(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.

(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).

(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.

(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).

(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).

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Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Kazakhstan	5	5	170	Aquifer mostly confined, but some parts unconfined	Sediment - Sand	High primary porosity fine/medium sedimentary deposits	No secondary porosity	940
Russian Federation	5	5	60	Aquifer mostly confined, but some parts unconfined	Sediment - Sand	High primary porosity fine/medium sedimentary deposits	No secondary porosity	
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

AS31 - South-Pred-Ural

Aquifer description

Aquifer geometry

Regionally this is multiple-layered hydraulically connected system consisting of 4 main layers. The average depth to the piezometric water level is 5m. The average depth to the top of the shallower aquifer is 5m. The average thickness of the aquifer system varies from 60m within Russia to 170m within Kazakhstan. The aquifer is mostly confined, but some parts are unconfined.

Hydrogeological aspects

The predominant lithology is sediments – sands that is underlain by sedimentary rocks – sandstone. The formations have a low to high primary porosity and no secondary porosity and a high horizontal and a low vertical connectivity. The average transmissivity value is 940m^2/day (Kazakhstan). The total groundwater volume is 110km^3. The mean annual recharge is 280Mm^3/annum.

Linkages with other water systems

Recharge is predominantly through precipitation over the aquifer area, while the predominant discharge mechanism is through river base flow.

Environmental aspects

Within Russia the natural quality of the groundwater on some sites does not satisfy drinking water standards due to the high natural salinity levels but the percentage of the aquifer affected was not quantified. The level of anthropogenic pollution is still low in Russia. No information is available on shallow groundwater and on groundwater-dependent ecosystems. No such environmental information is available for Kazakhstan.

Socio-economic aspects

During 2010 the annual groundwater abstraction from the system was 22 Mm^3/annum and that was mainly used for domestic purposes within Kazakhstan, whereas that in Russia was 250 Mm^3/annum. The total amount of fresh water that was abstracted over the aquifer area was not recorded. There appear to be no signs of groundwater depletion.

Legal and Institutional aspects

No information was recorded with regard to the current status of transboundary legal and institutional matters. Information was also not recorded with regard to the status of the mandate and capacity for groundwater management of national institutions.

Emerging Issues

Groundwater abstraction in Russia is much higher than in Kazakhstan and is close to the estimated mean annual recharge of the aquifer. However, the countries report that both within Russia and Kazakhstan, no significant groundwater abstraction is taking place close to the border and so no major issues have been listed. Steps for joint monitoring of abstraction, water levels and water quality of this productive and vulnerable transboundary resource should however be taken as a matter of urgency and a bilateral agreement on joint use should be reached.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Dmitrii Plaksin		Kyrgyzstan	plaksind@ya.ru	Regional coordinator
Lucila Candela	Universidad Politécnica de Catalunya	Spain	Lucila.Candela@upc.edu	Regional coordinator
Aleksandr Kuchin	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	agkuchin@gmail.com	Contributing national expert

AS31 - South-Pred-Ural

Name	Organisation	Country	E-mail	Role
Oleg Podolny	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	podolnyo@mail.ru	Lead National Expert
Boris Korolev	Federal state unitary geological organization "Hydrospecialgeology"	Russia	korolyev@mail.ru	Contributing national expert

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Both countries have provided data to describe the aquifer adequately, but there was not enough numerical information to allow calculation of groundwater indicators at the transboundary level

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

Request:
If you have additional data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

References:
- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

Version: December 2015

AS11 - Syrt

Geography

Total area TBA (km^2): 160 000

No. countries sharing: 2

Countries sharing: Russia, Kazakhstan

Population: 3 600 000

Climate Zone: Semi-arid

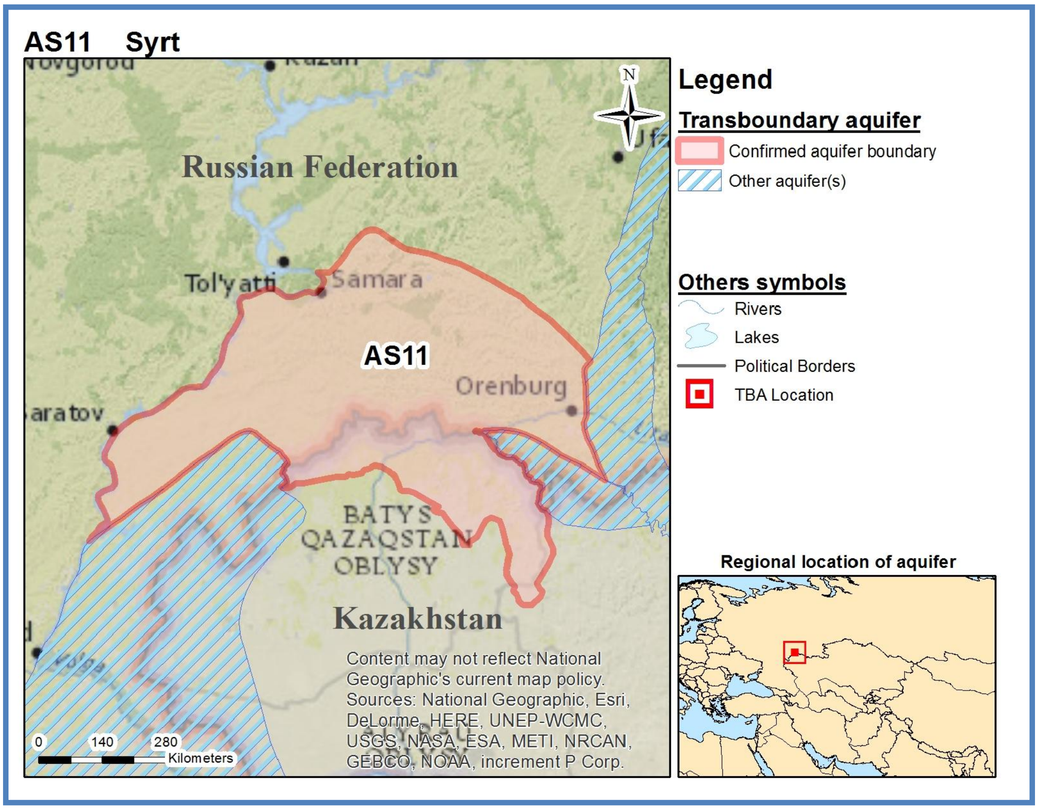
Rainfall (mm/yr): 420

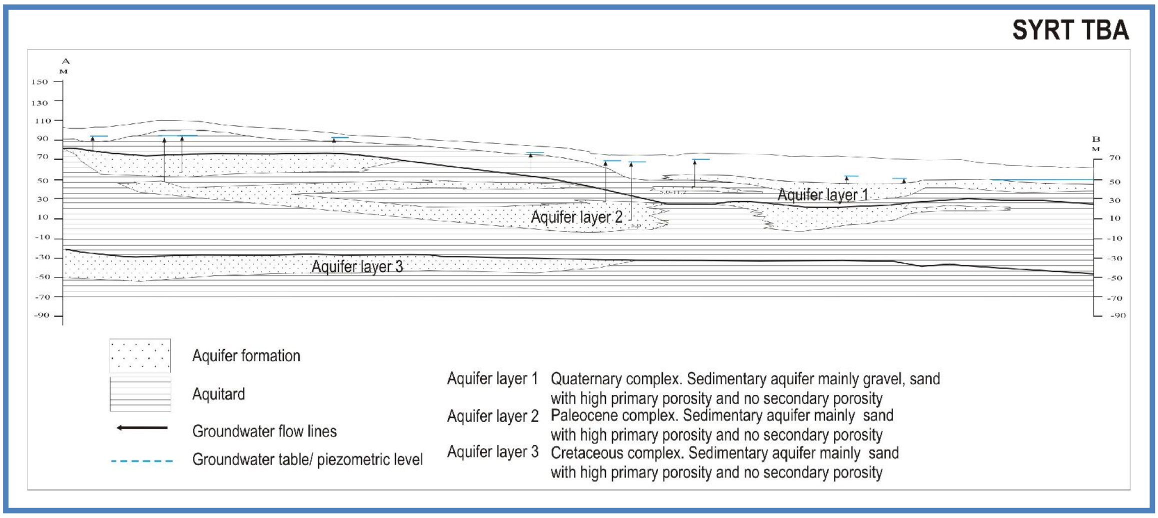
Hydrogeology

Aquifer type: Multiple-layered hydraulically connected

Degree of confinement: Mostly unconfined, but some parts are confined

Main Lithology: Sediment - Sand





Hydrogeological cross-section of the Syrt Transboundary Aquifer

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

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TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Kazakhstan	2	200			0		11	15	D	E
Russian Federation					0		26		D	E
TBA level					**0**		**23**		**D**	**E**

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Kazakhstan	21	2000	5	-1	31	35	5	31
Russian Federation	58	2400	32	55	9	13	12	5
TBA level	**50**	**2400**	**29**	**46**	**11**	**15**	**12**	**8**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Kazakhstan	0	10	18	31	4	1	1
Russian Federation	1	24	-6	-15	1	0	0
TBA level	**1**	**21**	**-3**	**-10**	**2**	**0**	**0**

AS11 - Syrt

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Kazakhstan	11	11	60	Aquifer Mostly unconfined, but some parts confined	Sediment - Sand	High Primary porosity fine/ medium sedimentary deposits	No Secondary porosity	300
Russian Federation	12	12	40	Aquifer Mostly unconfined, but some parts confined	Sediment - Sand	High Primary porosity fine/ medium sedimentary deposits	No Secondary porosity	100
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

Aquifer geometry

This is a multi-layered system, with 3 major aquifer horizons in Kazakhstan and 4 in the Russian Federation. The average depth to the water table as well as the average depth to the top of the aquifer is is 11m within Kazakhstan and 12m within the Russian Federation. The average total thickness of the aquifer system varies between 60 and 40m within the two countries respectively. The aquifer is mostly unconfined, but some parts are confined.

Hydrogeological aspects

All aquifers are sedimentary, mainly sand and gravel with high primary porosity and no secondary porosity in the upper layer and in the lower levels mainly sandstone and limestone with high primary porosity and no secondary porosity. There is high horizontal connectivity and low vertical connectivity. Average transmissivity is 300 m^2/d in Kazakhstan and 100 m^2/d in the Russian Federation. The average groundwater volume is $71km^3$. The average annual recharge within Kazakhstan is $73Mm^3$/annum.

Linkages with other water system

The predominant source of recharge is precipitation on the aquifer area and the predominant groundwater discharge mechanism is through river base flow and evapotranspiration. Some indication of flow direction on both sides of the Ural River is provided in the Appendix.

Environmental aspects

The natural quality of groundwater in some locations, but over a significant part of the aquifer within Kazakhstan, does not satisfy local drinking water standards with respect to elevated natural salinity, Fe, Mn, and Br. Some pollution is occurring on the Russia part but to date no pollution as yet has been detected on the Kazakhstan part of the TBA. The pollution is mainly from municipalities

AS11 - Syrt

resulting in elevated nitrogen species. No information is available on the occurrence of shallow groundwater and of groundwater dependent ecosystems.

Socio-economic aspects

The mean annual volume of groundwater abstraction in Kazakhstan is 12 Mm^3/annum, mainly for domestic use and in Russia it is 400 Mm^3/annum. There is no data available on groundwater depletion.

Legal and Institutional aspects

There is no Transboundary Agreement in place and although it is reported that in both countries there is no National Institution in place with the appropriate mandate, groundwater abstraction, groundwater quality protection, and drilling control are done according to law/ regulations, and measures are also applied in practice.

Emerging issues

Russia has not provided recharge figures, but the abstraction in Russia is high and could be of the order of mean annual recharge. No groundwater development is presently taking place close to the border, which if developed could result in a cross-border issue. Groundwater use and quality should be monitored by both countries and attrition should be given to a bilateral agreement.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
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Lucila Candela	Universidad Politécnica de Catalunya	Spain	Lucila.Candela@upc.edu	Regional coordinator
Aleksandr Kuchin	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	agkuchin@gmail.com	Contributing national expert
Oleg Podolny	Hydrogeological research and design company "KazHYDEC" Ltd.	Kazakhstan	podolnyo@mail.ru	Lead National Expert
Boris Korolev	Federal state unitary geological organization "Hydrospecialgeology"	Russia	korolyev@mail.ru	Contributing national expert

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Both countries have provided data to describe the aquifer adequately, but there was not enough numerical information to allow calculation of groundwater indicators at the transboundary level.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

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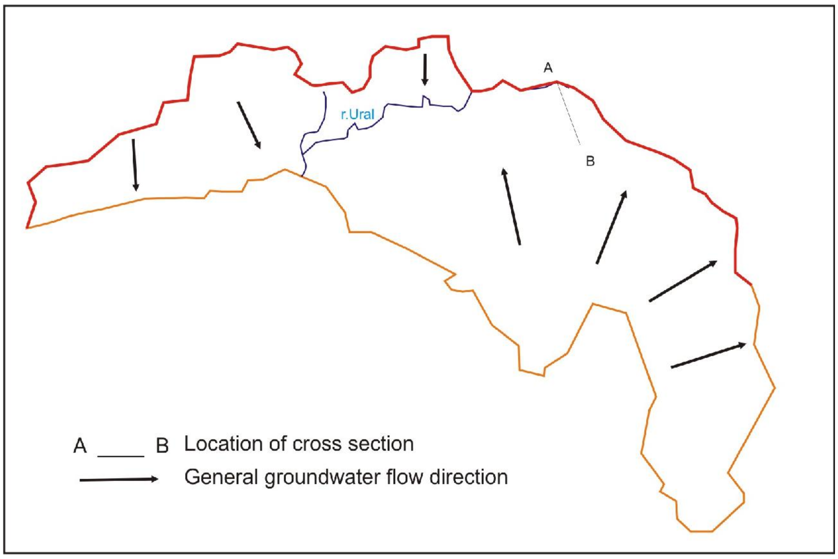
Appendix: AS11

SYRT TBA



Indicating Syrt Groundwater flow directions

Colophon

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zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).

- All other data: TWAP Groundwater (2015).

Version: December 2015

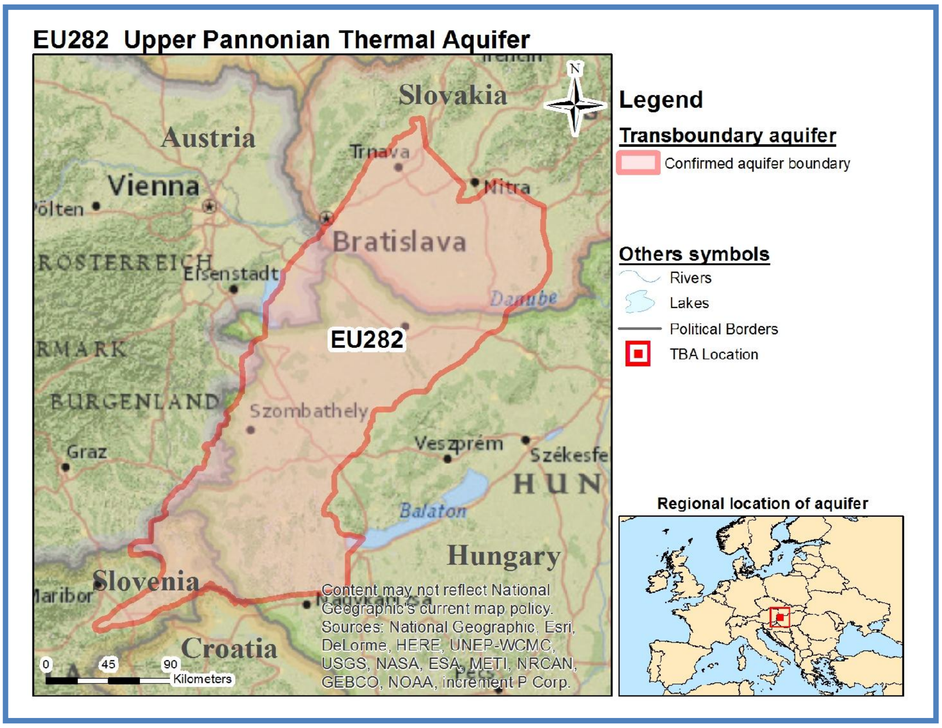
EU282 – Upper Pannonian Thermal Aquifer

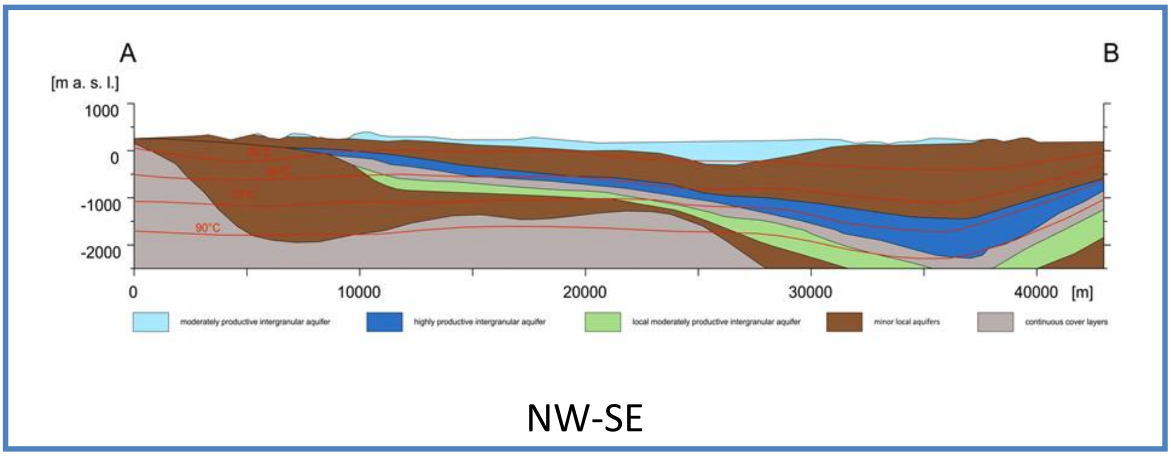
Geography

Total area TBA (km^2): 20 000
No. countries sharing: 5
Countries sharing: Hungary, Slovakia, Slovenia, Austria, Croatia
Population: 2 200 000
Climate zone: Marine
Rainfall (mm/yr): 640

Hydrogeology

Aquifer type: Multi-layered
Degree of confinement: Confined
Main Lithology: Sediment – Sand/gravel/clay, crystalline basement





Cross-section across the NW-SE part of the Aquifer

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate.

EU282 – Upper Pannonian Thermal Aquifer

TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Austria							95			
Croatia							214			
Hungary	530	6600	100		0		81		A	D
Slovakia					0		152		D	B
Slovenia	13	77	100		0	A	162	20		D
TBA level							**110**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).

(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.

(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).

(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.

(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).

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X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Austria	98	1100	-9	-10	42	81	55	28
Croatia	160	1700	-4	-2	41	48	51	28
Hungary	78	960	-5	-4	26	36	28	18
Slovakia	82	480	-6	-2	15	62	8	7
Slovenia	170	1100	-4	-3	22	46	45	9
TBA level	**88**	**760**	**-6**	**-4**	**20**	**50**	**17**	**11**

EU282 – Upper Pannonian Thermal Aquifer

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Austria	0	91	-1	-6	16	2	3
Croatia	0	94	-3	-10	3	0	0
Hungary	0	82	-5	-12	6	1	1
Slovakia	0	170	-1	-9	14	1	0
Slovenia	0	160	-3	-10	5	0	0
TBA level	**0**	**120**	**-3**	**-10**	**9**	**1**	**1**

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Primary Porosity	Secondary Porosity	Transmissivity (m^2/d)
Austria								
Croatia								
Hungary	7	50	800	Whole aquifer confined	Sediment - Sand	High primary porosity fine/ medium sedimentary deposits	No secondary porosity	<5
Slovakia		230		Whole aquifer confined		High primary porosity fine/ medium sedimentary deposits	Secondary porosity: Fractures	
Slovenia	<5	50	800	Whole aquifer confined	Sediment - Sand	High primary porosity fine/ medium sedimentary deposits	Secondary porosity: Fractures	40
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

UNEP gef United Nations Educational, Scientific and Cultural Organization International Hydrological Programme igrac International Groundwater Resources Assessment Centre

EU282 – Upper Pannonian Thermal Aquifer

Aquifer description

Aquifer geometry

The aquifer system is multi-layered, hydraulically connected and confined system with an average thickness varying between 230 and 800m for the different shared countries, in places up to 2300 m thick. The average distance to the top of the aquifer varies between 50m and 230m, while the average groundwater levels are between close to and 7m below the surface.

Hydrogeological aspects

Located in the western part of the Pannonian Basin (late Miocene and Pliocene) within the Danube river basin, in the transboundary zone of Austria, Hungary, Slovak Republic, Croatia and Slovenia, this aquifer system comprises two separate aquifer systems, the porous system that consists of sediment – sand, and the basement system, that consists of crystalline rocks. The confined aquifer system is composed of unconsolidated deltaic and alluvial sand gravel and clay layers, with high primary porosity and hydraulically connected. Slovenia has estimated and average transmissivity of 40m^2/day, going to a maximum of 350m^2/day. Hungary has estimated the mean annual groundwater recharge as 6 000 Mm^3/annum occurring over an area of 20 000 km^2. Groundwater volumes from 3 countries (Hungary, Slovakia, Slovenia) add up to 2 300km^3 but this should be reviewed.

Linkages with other water systems

Groundwater recharge is from precipitation and from overlying quaternary sediments while the complex regional flow discharges through river base flow, and through other connected aquifer levels and some springs in the Slovenian border. At greater depths, along the deeper flow paths the groundwater warms up, a geothermal water system develops (45-140ºC) (see Appendix 1), and brine waters are found in the basin area due to water-rock interaction.

Environmental aspects

The occurrence of groundwater salinity of natural origin is reported. Slovakia reports that it covers a significant part of the aquifer. Slovenia reports on the elevated presence of arsenic, iron and manganese within the natural groundwater that are at problem levels. No pollution has been identified to date. Hungary and Slovenia report shallow groundwater over 65% and 90% of the aquifer respectively and 2% and 30% coverage with groundwater dependent ecosystems. However, these reported areas may not be entirely associated with the transboundary aquifer, i.e. they may rely on other aquifers, since these are un-realistic figures for a confined aquifer.

Socio-economic aspects

At this stage, the level of exploitation remains low (2.2 Mm^3/annum and 3.9Mm^3/annum in Slovakia and Slovenia respectively), although in some local areas a groundwater level drawdown and disappearance of springs has resulted. No country fresh water abstraction information was provided.

Legal and Institutional aspects

A Groundwater Management Agreement between Hungary and Austria exists, while state regulations apply to the different member states. Hungary reports a National Institution with full mandate and capacity.

Priority issues

The foreseen industrial water abstraction by new thermal wells and the spread of the cone of depression constitute the most important transboundary pressure factor.

EU282 – Upper Pannonian Thermal Aquifer

Contributors to Global Inventory

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Lucila Candela	Universidad Politécnica de Catalunya	Spain	Lucila.Candela@upc.edu	Regional coordinator
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Joerg Prestor	Geological Survey of Slovenia	Slovenia	joerg.prestor@geo-zs.si	Contributing national expert

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Only two of the five transboundary countries have provided adequate information to describe the complex aquifer system. No calculation of transboundary indicators was possible.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

EU282 – Upper Pannonian Thermal Aquifer

Appendix 1: EU282

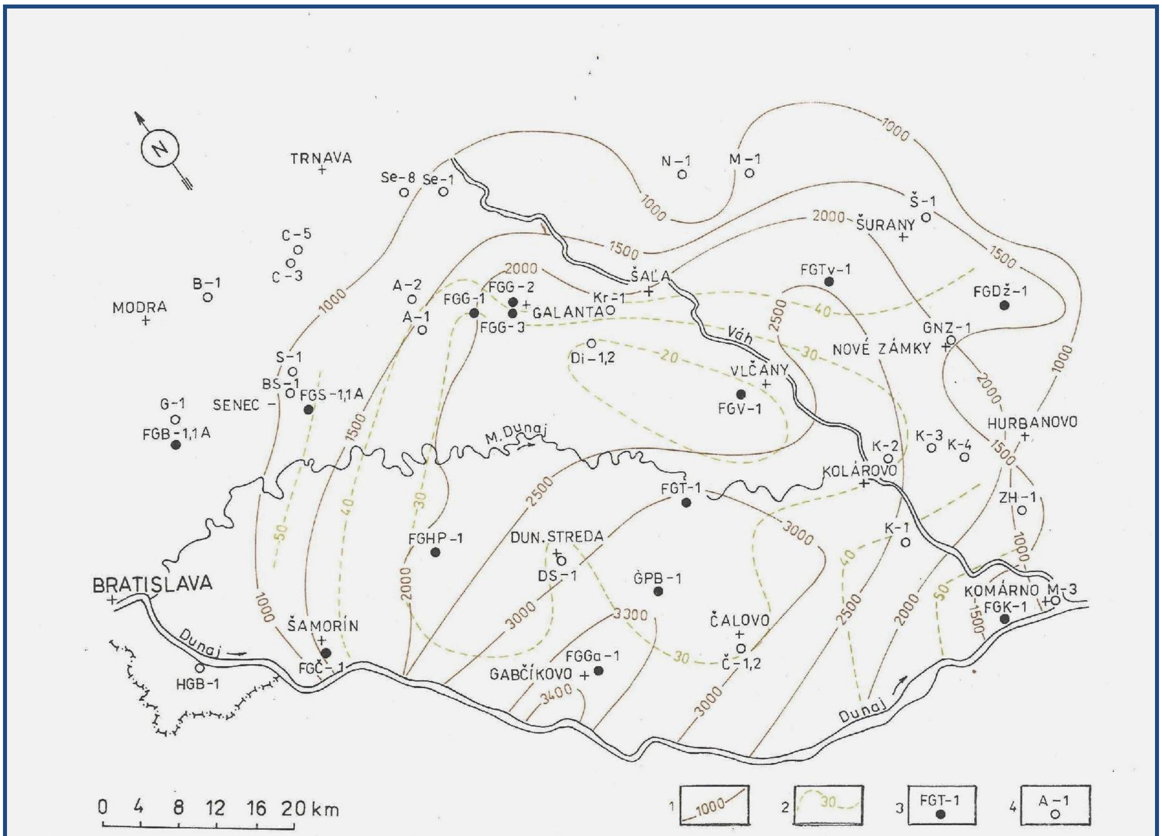

Fig. 1 Spatial delimitation of geothermal water reservoir in central depression of Danube Basin
1 – Pannonian base isolines, 2 – percentage of aquifers, 3 – geothermal well, 4 – oil well

Spatial delineation of the central geothermal reservoir within the Upper Pannonian Thermal Aquifer

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

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Request:
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References:

EU282 – Upper Pannonian Thermal Aquifer

- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
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- All other data: TWAP Groundwater (2015).

Version: December 2015

AS77 – Yenisei Upstream

Geography

Total area TBA (km^2): 130 000

No. countries sharing: 2

Countries sharing: Mongolia, Russia

Population: 150 000

Climate Zone: Semi-arid

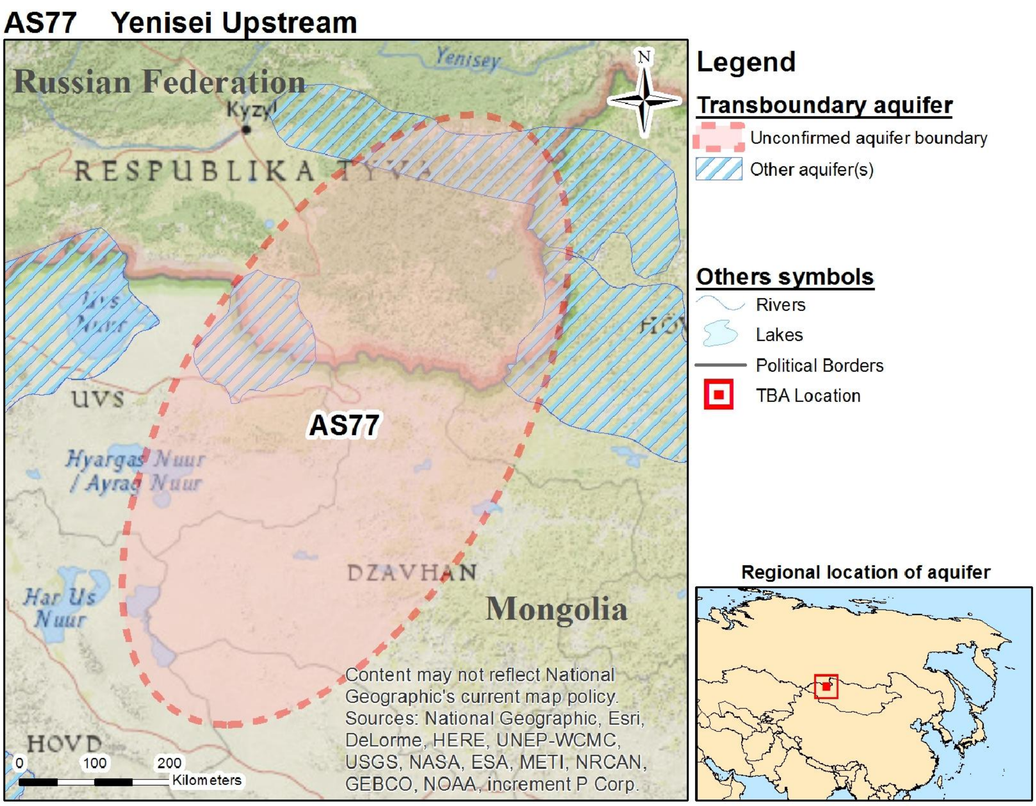
Rainfall (mm/yr): 230

Hydrogeology

Aquifer type: Data not available

Degree of confinement: Data not available

Main Lithology: Data not available



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

AS77 – Yenisei Upstream

TWAP Groundwater Indicators from Global Inventory

No data available.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Mongolia	82	70 000	-22	-33	12	79	26	0
Russian Federation	7	9200	14	26	19	20	17	80
TBA level	**57**	**55 000**	**-16**	**-25**	**12**	**49**	**26**	**0**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Mongolia	0	1	30	51	<1	0	0
Russian Federation	0	1	-2	-8	<1	0	0
TBA level	**0**	**1**	**21**	**36**	**<1**	**0**	**0**

Key parameters table from Global Inventory

No data available.

Aquifer description

No data available.

Contributors to Global Inventory

No contributions.

Considerations and recommendations

Request:
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AS77 – Yenisei Upstream

Colophon

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- All other data: TWAP Groundwater (2015).

Version: December 2015

AS105 - Zeya River Basin

Geography

Total area TBA (km^2): 77 100

No. countries sharing: 2

Countries sharing: China, Russia

Population: 680 000

Climate Zone: Humid Continental

Rainfall (mm/yr): 580

Hydrogeology

Aquifer type: Data not available

Degree of confinement: Data not available

Main Lithology: Data not available

No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate.

AS105 - Zeya River Basin

TWAP Groundwater Indicators from Global Inventory

No data available.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
China	67	7300	12	22	25	37	46	6
Russian Federation	79	8800	18	30	28	33	35	21
TBA level	**77**	**8500**	**17**	**29**	**27**	**34**	**42**	**20**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
China	-1	9	2	-8	1	0	0
Russian Federation	-1	9	-5	-14	1	0	0
TBA level	**-1**	**9**	**-4**	**-13**	**1**	**0**	**0**

Key parameters table from Global Inventory

No data available.

Aquifer description

No data available.

Contributors to Global Inventory

No contributions.

Considerations and recommendations

Request:

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AS105 - Zeya River Basin

Colophon

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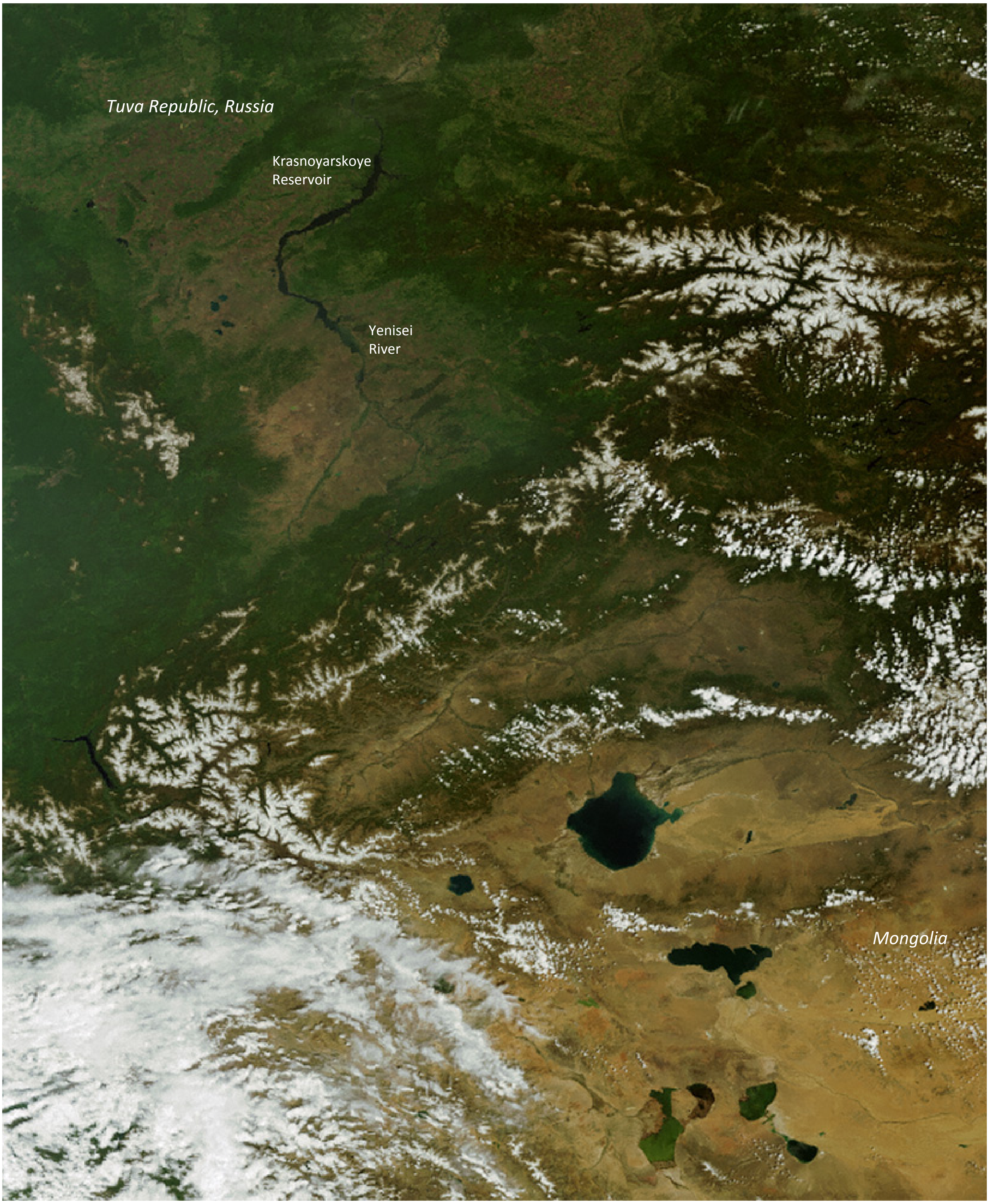
Version: October 2015

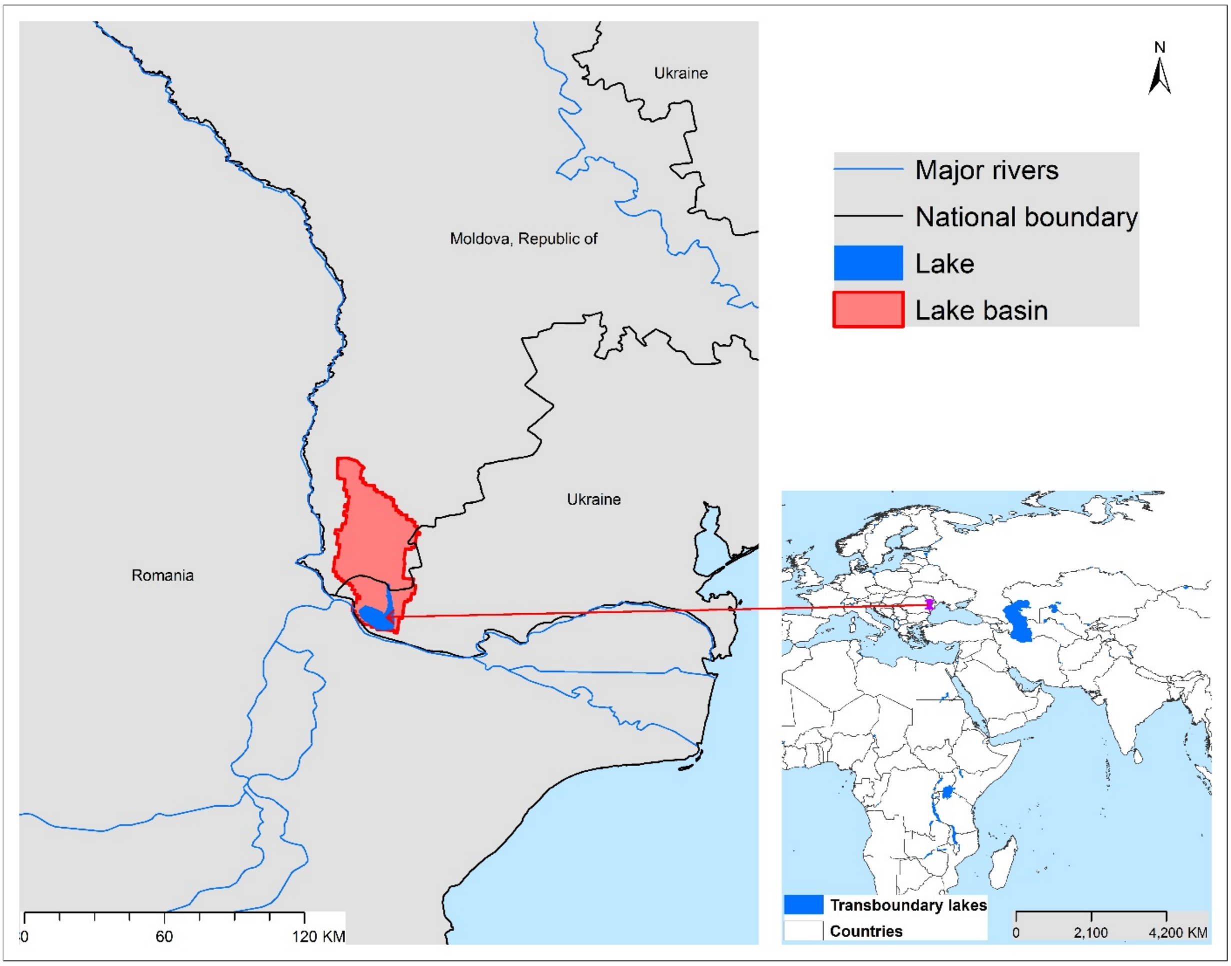


Chelys at http://www.eosnap.com/tag/yenisei-river/page/2/

1. Cahul
2. Caspian Sea
3. Neusiedler/ Fertö
4. Szczecin Lagoon

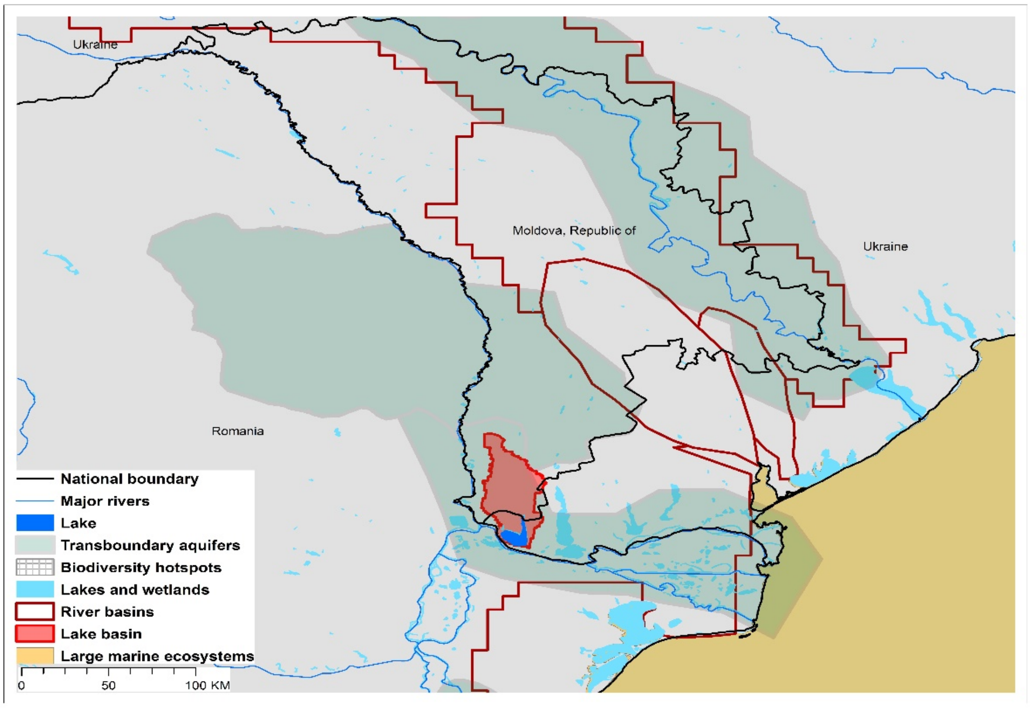
Lake Cahul — Geographic Information

The information for Lake Cahul was determined primarily on GIS-based spatial analysis, utilizing data on the characteristics of its drainage basin. There is little available information in the literature on this lake, although it is a small lake apparently utilized primarily for recreational purposes. The possibility for GEF-catalyzed management interventions is not clear, and requires further assessment of the present status of the lake and its basin.

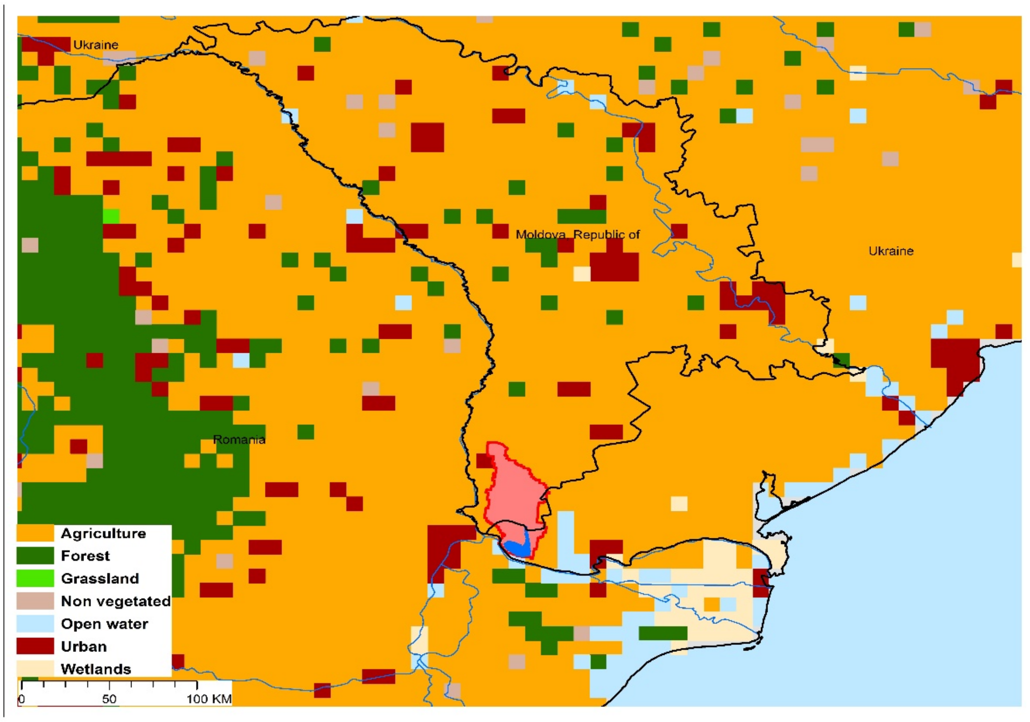


TWAP Regional Designation	Eastern Europe	**Lake Basin Population (2010)**	44,155
River Basin	Danube	**Lake Basin Population Density (2010; # km^{-2})**	24.2
Riparian Countries	Moldova, Ukraine	**Average Basin Precipitation (mm yr^{-1})**	480.8
Basin Area (km^2)	1,182	**Shoreline Length (km)**	80.1
Lake Area (km^2)	89.0	**Human Development Index (HDI)**	0.69
Lake Area:Lake Basin Ratio	0.077	**International Treaties/Agreements Identifying Lake**	No

Lake Cahul Basin Characteristics



(a) Lake Cahul basin and associated transboundary water systems



(b) Lake Cahul basin land use

Lake Cahul Threat Ranking

A serious lack of global-scale uniform data on the TWAP transboundary in-lake conditions required their potential threat risks be estimated on the basis of the characteristics of their drainage basins, rather than in-lake conditions. Using basin characteristics to rank transboundary lake threats precludes consideration of the unique features that can buffer their in-lake responses to basin-derived disturbances, including an integrating nature for all inputs, long water retention times, and complex, non-linear response dynamics.

The lake threat ranks were calculated with a spreadsheet-based interactive scenario analysis program, incorporating data and information about the nature and magnitude of their basin-derived stresses, and their possible impacts on the sustainability of their ecosystem services. These descriptive data for Lake Cahul and the other transboundary lakes included lake and basin areas, population numbers and densities, areal extent of basin stressors on the lake, data grid size, and other components considered important from the perspective of the user of the data results. The scenario analysis program also provides a means to define the appropriate context and preconditions for interpreting the ranking results.

The Lake Cahul threat ranks are expressed in terms of the Adjusted Human Water Security (Adj-HWS) threats, Reverse Biodiversity (RvBD) threats, and the Human Development Index (HDI) score, as well as combinations of these indices. However, it is emphasized that, being based on specific characteristics and assumptions regarding Lake Cahul and its basin characteristics, the calculated threat scores represent only one possible set of lake threat rankings. Defining the appropriate context and preconditions for interpreting the lake rankings remains an important responsibility of those using the threat ranking results, including lake managers and decision-makers.

Table 1. Lake Cahul Relative Threat Ranks, Based on Adjusted Human Water Security (Adj-HWS) and Reverse Biodiversity Threats, and Human Development Index (HDI) Score

(Estimated risks: red – highest; orange – moderately high; yellow – medium; green – moderately low; blue – low)

Adjusted Human Water Security (Adj-HWS) Threat Score	Relative Adj-HWS Threat Rank		Reverse Biodiversity (RvBD) Threat Score	Relative RvBD Threat Rank		Human Development Index (HDI) Score	Relative HDI Rank
0.82	29		0.39	51		0.69	31

It is emphasized that the Lake Cahul rankings above are discussed here within the context of the management and decision-making process, rather than as strict numerical ranks. Based on its geographic, population and socioeconomic assumptions used in the scenario analysis program, the calculated Adj-HWS score for Lake Cahul indicates a medium threat rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Lake Cahul, which is meant to describe its biodiversity sensitivity to basin-derived degradation, places the lake in a low threat rank, compared to the other transboundary lakes. Management interventions directed to improving the biodiversity status must be viewed with caution, however, since we lack sufficient knowledge and experience to accurately predict the ultimate impacts of biodiversity manipulations and preservation efforts. Further, the RvBD scores indicate the relative sensitivity of a lake basin to human activities, and high threat scores *per se* do not necessarily justify management interventions. Such interventions may actually increase biodiversity degradation, noting that many developed countries have already fundamentally degraded their biodiversity because of economic development activities. Thus, activities undertaken to address the Adj-HWS threats may actually degrade the biodiversity status and resources, even if the health and socioeconomic conditions of the lake basin stakeholders are improved as a result of better conditions, thereby increasing stakeholder resource consumption.

The relative Human Development Index (HDI) places the Lake Cahul basin in a moderately low threat rank in regard to its health, educational and economic conditions.

Table 2. Lake Cahul Threat Ranks, Based on Multiple Ranking Criteria

(Scores for Adj-HWS, RvBD and HDI ranks are presented in Table 1; the ranks may differ in some cases because of rounding of tied threat scores; Estimated risks: red – highest; orange – moderately high; yellow – medium;
green – moderately low; blue – low)

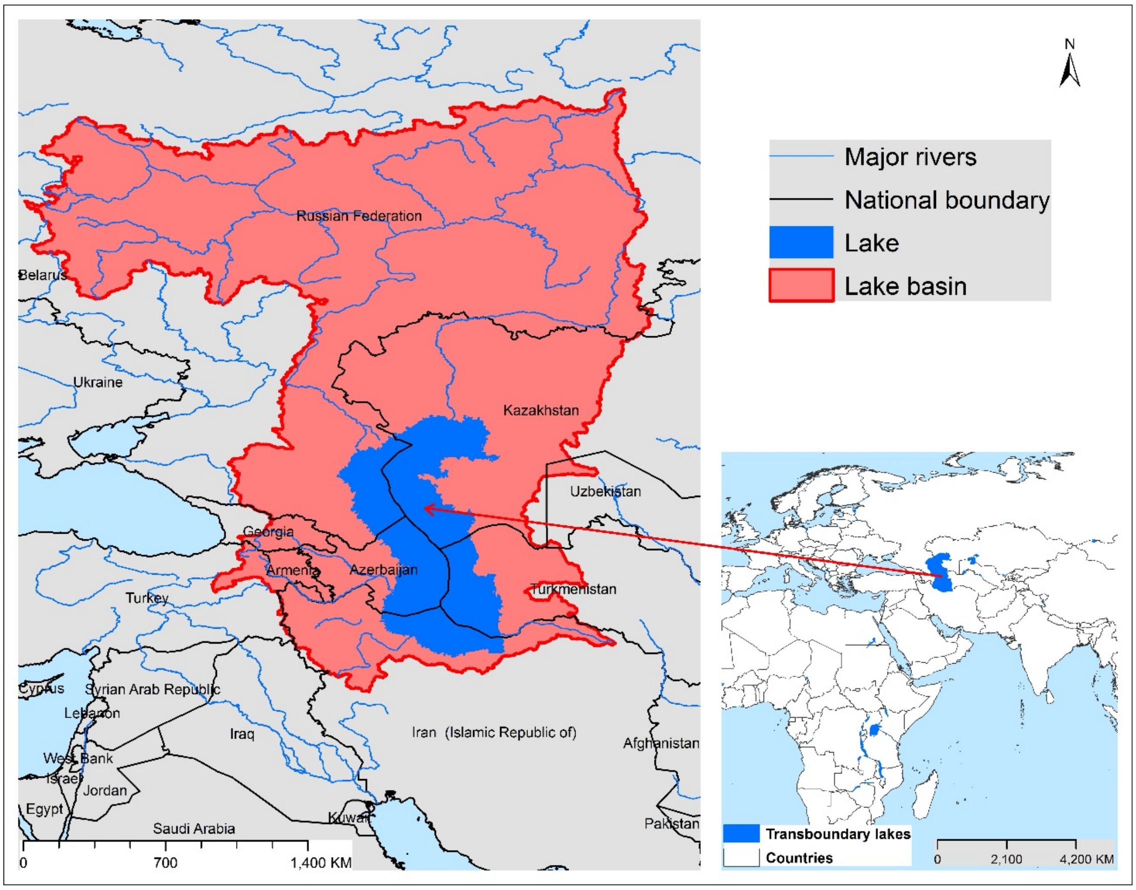
Adj-HWS Rank	HDI Rank	RvBD Rank		Sum Adj-HWS + RvBD	Relative Threat Rank		Sum Adj-HWS + HDI	Relative Threat Rank		Sum Adj-HWS + RvBD + HDI	Overall Threat Rank
30	31	51		81	42		61	33		112	29

When multiple ranking criteria are considered together in the threat rank calculations, the Adj-HWS and HDI scores considered together place Lake Cahul in the lower half of the threat ranks. The relative threat is somewhat reduced when the Adj-HWS and RvBD threats are considered together. Considering all three ranking criteria together, Lake Cahul exhibits a moderately low threat ranking.

Interactions between the ranking parameters for Lake Cahul indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Lake Cahul must be considered on the basis of educated judgement and accurate representations of its situation. A fundamental question will be how can one decide a given management intervention will produce the greatest benefit(s) for the greatest number of people in the Lake Cahul basin? Accurate answers to such questions for Lake Cahul, and other transboundary lakes, will require a case-by-case assessment approach that considers the specific lake situation and the anticipated improvements from specific management interventions, as well as interactions with water systems to which the lake is linked.

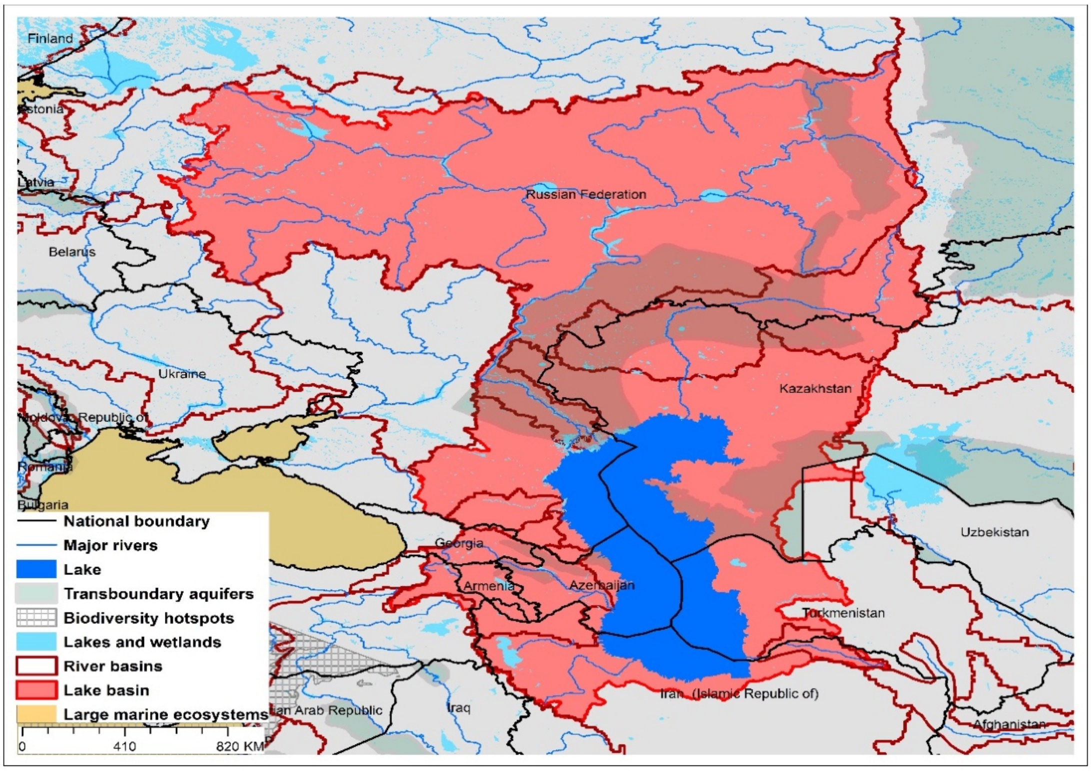
Caspian Sea — Geographic Information

The Caspian Sea, a terminal lake, is the world's largest single enclosed inland waterbody. It also is the largest salt lake in the world, containing about one-third of its inland surface waters, with a mean salinity about one-third of Earth's oceans. The Volga River contributes about 80% of its inflow. The lake has exhibited dramatic water level changes over the centuries synchronized largely with Volga River inflows, and more recently to climate change. The Volga River is thought to be the principal source of transboundary contaminants to the lake. The lake contains a heavily-exploited sturgeon population (caviar source), to the point banning sturgeon fishing has been advocated until the population recovers, although the high caviar prices constrain this goal. Another major environmental concern is oil and natural gas production activities along the lake edges. The lake has already received GEF funding, and consideration of further GEF-catalyzed management interventions requires a review of its GEF status.

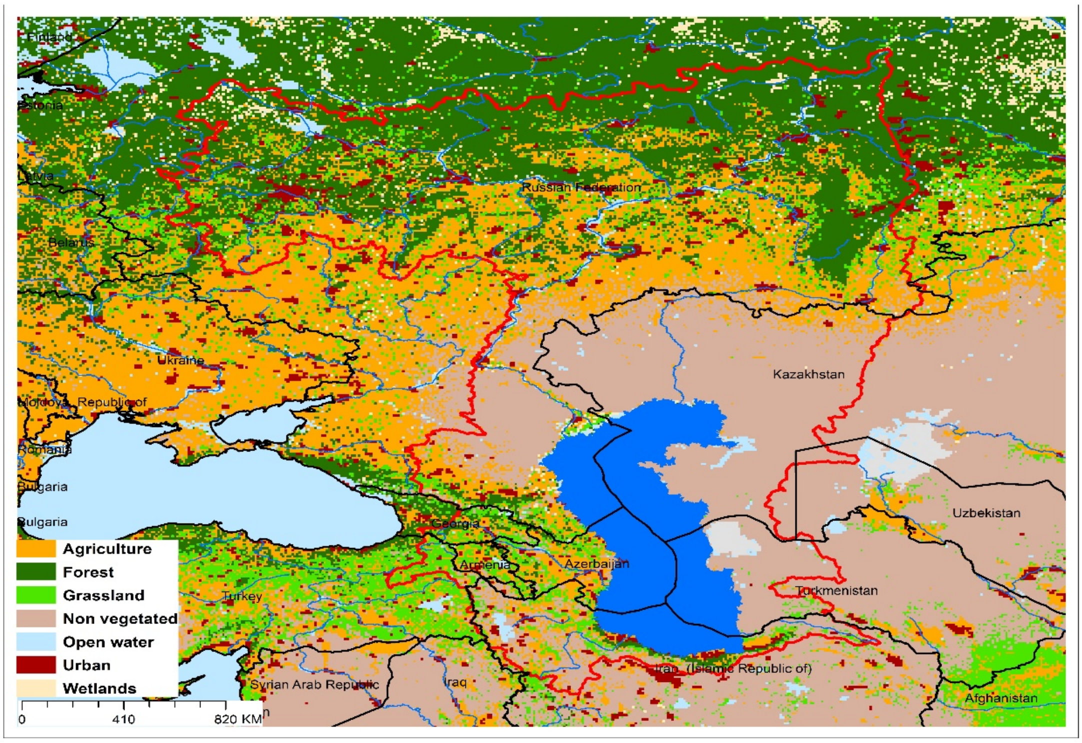


TWAP Regional Designation	Northern Africa & Western Asia; Eastern & Central Asia; Southern Asia; Eastern Europe	Lake Basin Population (2010)	105,000,000
River Basin	Caspian (endorheic)	Lake Basin Population Density (2010; # km^{-2})	20.1
Riparian Countries	Azerbaijan, Iran, Kazakhstan, Russia	Average Basin Precipitation (mm yr^{-1})	448.5
Basin Area (km^2)	3,412,322	Shoreline Length (km)	9,042
Lake Area (km^2)	377,543	Human Development Index (HDI)	0.77
Lake Area:Lake Basin Ratio	0.117	International Treaties/Agreements Identifying Lake	Yes

Caspian Sea Basin Characteristics



(a) Caspian Sea basin and associated transboundary water systems



(b) Caspian Sea basin land use

Caspian Sea Threat Ranking

A serious lack of global-scale uniform data on the TWAP transboundary in-lake conditions required their potential threat risks be estimated on the basis of the characteristics of their drainage basins, rather than in-lake conditions. Using basin characteristics to rank transboundary lake threats precludes consideration of the unique features that can buffer their in-lake responses to basin-derived disturbances, including an integrating nature for all inputs, long water retention times, and complex, non-linear response dynamics.

The lake threat ranks were calculated with a spreadsheet-based interactive scenario analysis program, incorporating data and information about the nature and magnitude of their basin-derived stresses, and their possible impacts on the sustainability of their ecosystem services. These descriptive data for Caspian Sea and the other transboundary lakes included lake and basin areas, population numbers and densities, areal extent of basin stressors on the lake, data grid size, and other components considered important from the perspective of the user of the data results. The scenario analysis program also provides a means to define the appropriate context and preconditions for interpreting the ranking results.

The Caspian Sea threat ranks are expressed in terms of the Adjusted Human Water Security (Adj-HWS) threats, Reverse Biodiversity (RvBD) threats, and the Human Development Index (HDI) score, as well as combinations of these indices. However, it is emphasized that, being based on specific characteristics and assumptions regarding Caspian Sea and its basin characteristics, the calculated threat scores represent only one possible set of lake threat rankings. Defining the appropriate context and preconditions for interpreting the lake rankings remains an important responsibility of those using the threat ranking results, including lake managers and decision-makers.

Table 1. Caspian Sea Relative Threat Ranks, Based on Adjusted Human Water Security (Adj-HWS) and Reverse Biodiversity Threats, and Human Development Index (HDI) Score

(Estimated risks: red – highest; orange – moderately high; yellow – medium; green – moderately low; blue – low)

Adjusted Human Water Security (Adj-HWS) Threat Score	Relative Adj-HWS Threat Rank		Reverse Biodiversity (RvBD) Threat Score	Relative RvBD Threat Rank		Human Development Index (HDI) Score	Relative HDI Rank
0.79	39		0.60	27		0.77	41

It is emphasized that the Caspian Sea rankings above are discussed here within the context of the management and decision-making process, rather than as strict numerical ranks. Based on its geographic, population and socioeconomic assumptions used in the scenario analysis program, the calculated Adj-HWS score for Caspian Sea indicates a moderately low threat rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Caspian Sea, which is meant to describe its biodiversity sensitivity to basin-derived degradation, places the lake in a medium threat rank, compared to the other transboundary lakes. Management interventions directed to improving the biodiversity status must be viewed with caution, however, since we lack sufficient knowledge and experience to accurately predict the ultimate impacts of biodiversity manipulations and preservation efforts. Further, the RvBD scores indicate the relative sensitivity of a lake basin to human activities, and high threat scores *per se* do not necessarily justify management interventions. Such interventions may actually increase biodiversity degradation, noting that many developed countries have already fundamentally degraded their biodiversity because of economic development activities. Thus, activities undertaken to address the Adj-HWS threats may actually degrade the biodiversity status and resources, even if the health and socioeconomic conditions of the lake basin stakeholders are improved as a result of better conditions, thereby increasing stakeholder resource consumption.

The relative Human Development Index (HDI) places the Caspian Sea basin in a moderately low threat rank in regard to its health, educational and economic conditions.

Table 2. Caspian Sea Threat Ranks, Based on Multiple Ranking Criteria

(Scores for Adj-HWS, RvBD and HDI ranks are presented in Table 1; the ranks may differ in some cases because of rounding of tied threat scores; Estimated risks: red – highest; orange – moderately high; yellow – medium;
green – moderately low; blue – low)

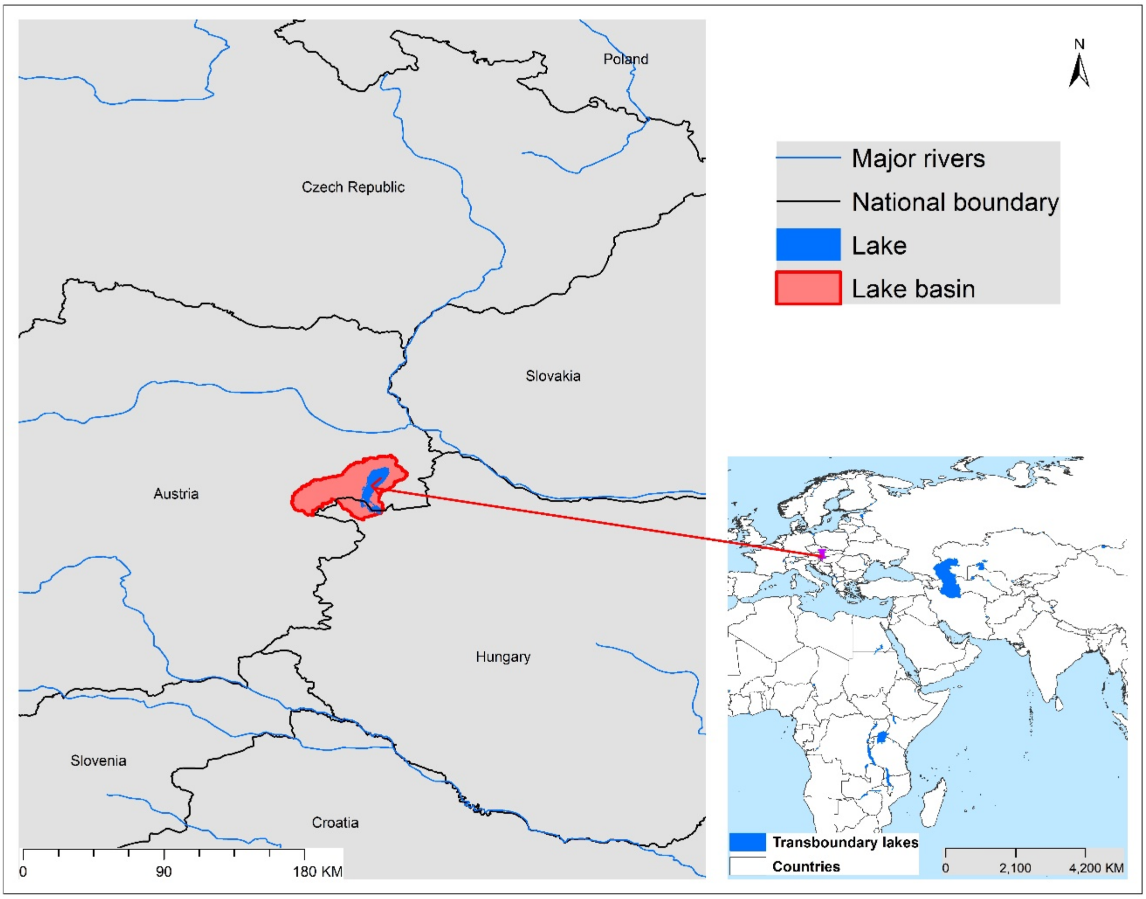
Adj-HWS Rank	HDI Rank	RvBD Rank		Sum Adj-HWS + RvBD	Relative Threat Rank		Sum Adj-HWS + HDI	Relative Threat Rank		Sum Adj-HWS + RvBD + HDI	Overall Threat Rank
39	41	27		66	36		80	40		107	38

When multiple ranking criteria are considered together in the threat rank calculations, the Adj-HWS and HDI scores considered together place Caspian Sea in the lower quarter of the threat ranks. The relative threat is somewhat increased when the Adj-HWS and RvBD threats are considered together. Considering all three ranking criteria together, Caspian Sea exhibits an overall moderately low threat ranking.

Interactions between the ranking parameters for Caspian Sea indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Caspian Sea must be considered on the basis of educated judgement and accurate representations of its situation. A fundamental question will be how can one decide a given management intervention will produce the greatest benefit(s) for the greatest number of people in the Caspian Sea basin? Accurate answers to such questions for Caspian Sea, and other transboundary lakes, will require a case-by-case assessment approach that considers the specific lake situation and the anticipated improvements from specific management interventions, as well as interactions with water systems to which the lake is linked.

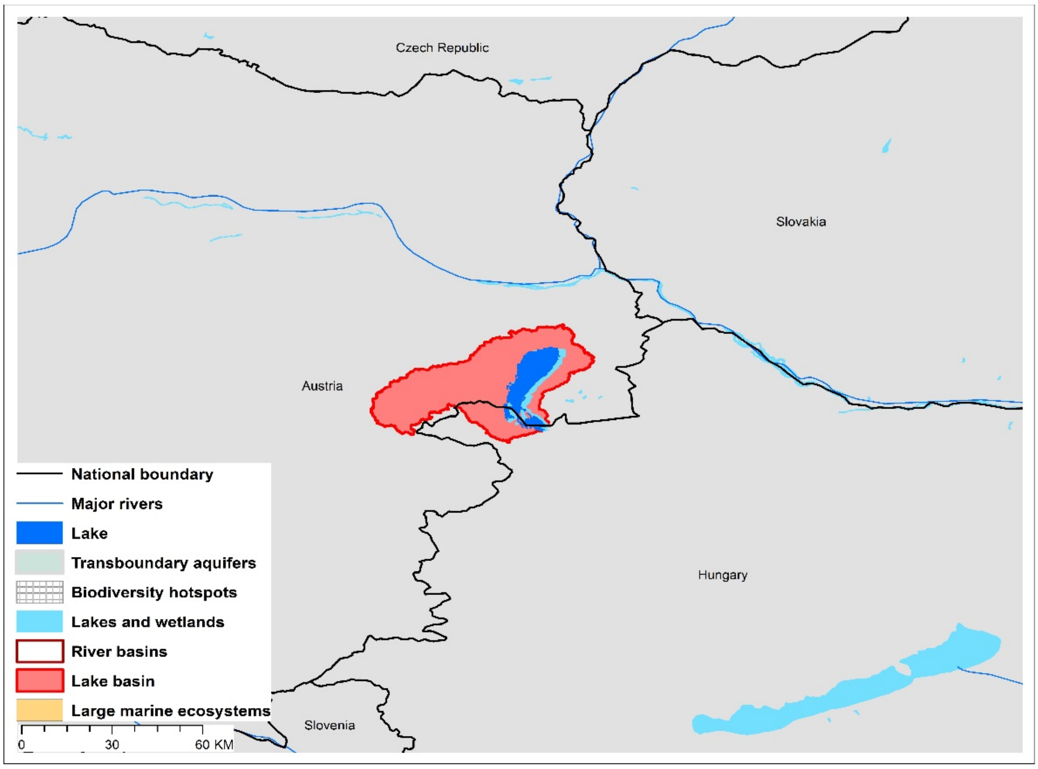
Lake Neusiedler/Fertő — Geographic Information

Lake Neusiedler, called Lake Fertő, straddles the Austria-Hungary border, being the largest endorheic lake in Central Europe. The lake is relatively shallow and marshy, being no more than about 1.8 deep. The lake experiences significant rising and falling water levels, with no clear relationship with the weather patterns. The water level is currently controlled by a sluice on Hungarian territory. Much of the lake is surrounded by reeds serving as a wildlife habitat, particularly a resting place for migratory birds. The reeds are also harvested in winter when the ice is solid, thereby removing organic matter that could decay in the lake. They are also used for construction and housing, thereby having an economic significance. A significant number of tourists visit the lake, particularly from Austria, with the lake providing sailing, windsurfing and commercial fishing opportunities.

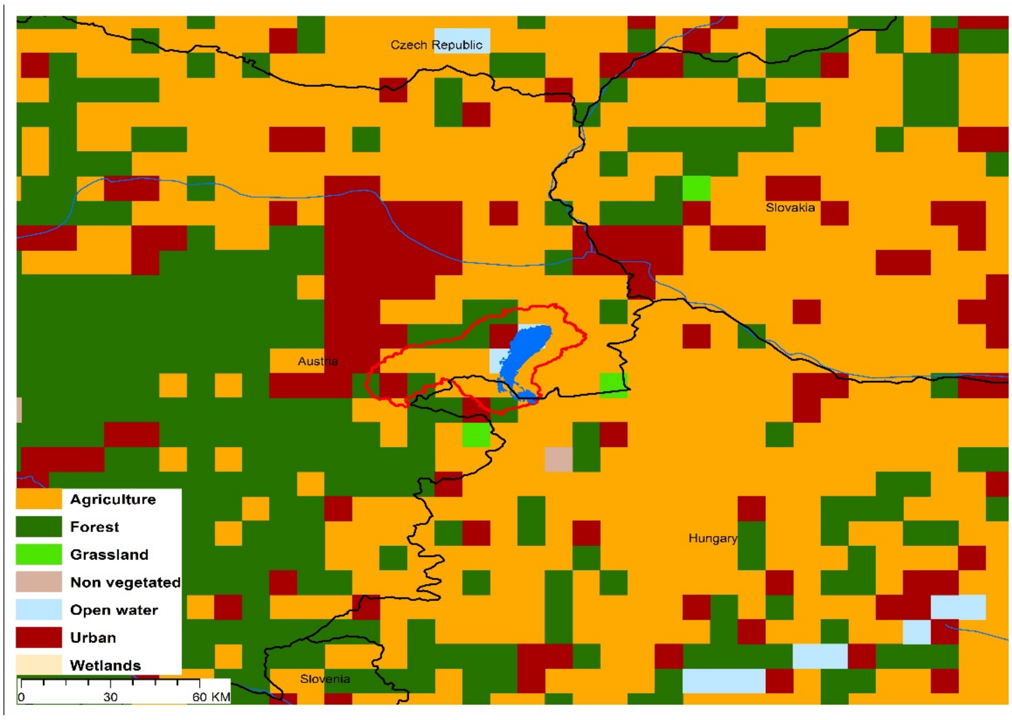


TWAP Regional Designation	Eastern Europe; Northern, Western & Southern Europe	**Lake Basin Population (2010)**	115,345
River Basin	Danube	**Lake Basin Population Density (2010; # km^{-2})**	69.6
Riparian Countries	Austria, Hungary	**Average Basin Precipitation (mm yr^{-1})**	627.1
Basin Area (km^2)	1,118	**Shoreline Length (km)**	199.0
Lake Area (km^2)	142.0	**Human Development Index (HDI)**	0.88
Lake Area:Lake Basin Ratio	0.132	**International Treaties/Agreements Identifying Lake**	No

Lake Neusiedler/Fertő Basin Characteristics



(a) Lake Neusiedler/Fertő basin and associated transboundary water systems



(b) Lake Neusiedler/Fertő basin land use

Lake Neusiedler/Fertő Threat Ranking

A serious lack of global-scale uniform data on the TWAP transboundary in-lake conditions required their potential threat risks be estimated on the basis of the characteristics of their drainage basins, rather than in-lake conditions. Using basin characteristics to rank transboundary lake threats precludes consideration of the unique features that can buffer their in-lake responses to basin-derived disturbances, including an integrating nature for all inputs, long water retention times, and complex, non-linear response dynamics.

The lake threat ranks were calculated with a spreadsheet-based interactive scenario analysis program, incorporating data and information about the nature and magnitude of their basin-derived stresses, and their possible impacts on the sustainability of their ecosystem services. These descriptive data for Lake Neusiedler/Fertő and the other transboundary lakes included lake and basin areas, population numbers and densities, areal extent of basin stressors on the lake, data grid size, and other components considered important from the perspective of the user of the data results. The scenario analysis program also provides a means to define the appropriate context and preconditions for interpreting the ranking results.

The Lake Neusiedler/Fertő threat ranks are expressed in terms of the Adjusted Human Water Security (Adj-HWS) threats, Reverse Biodiversity (RvBD) threats, and the Human Development Index (HDI) score, as well as combinations of these indices. However, it is emphasized that, being based on specific characteristics and assumptions regarding Lake Neusiedler/Fertő and its basin characteristics, the calculated threat scores represent only one possible set of lake threat rankings. Defining the appropriate context and preconditions for interpreting the lake rankings remains an important responsibility of those using the threat ranking results, including lake managers and decision-makers.

Table 1. Lake Neusiedler/Fertő Relative Threat Ranks, Based on Adjusted Human Water Security (Adj-HWS) and Reverse Biodiversity Threats, and Human Development Index (HDI) Score

(Estimated risks: red – highest; orange – moderately high; yellow – medium; green – moderately low; blue – low)

Adjusted Human Water Security (Adj-HWS) Threat Score	Relative Adj-HWS Threat Rank		Reverse Biodiversity (RvBD) Threat Score	Relative RvBD Threat Rank		Human Development Index (HDI) Score	Relative HDI Rank
0.58	42		0.61	50		0.88	47

It is emphasized that the Lake Neusiedler/Fertő rankings above are discussed here within the context of the management and decision-making process, rather than as strict numerical ranks. Based on its geographic, population and socioeconomic assumptions used in the scenario analysis program, the calculated Adj-HWS score for Lake Neusiedler/Fertő indicates a moderately low rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Lake Neusiedler/Fertő, which is meant to describe its biodiversity sensitivity to basin-derived degradation, places the lake in a low threat rank, compared to the other transboundary lakes. Management interventions directed to improving the biodiversity status must be viewed with caution, however, since we lack sufficient knowledge and experience to accurately predict the ultimate impacts of biodiversity manipulations and preservation efforts. Further, the RvBD scores indicate the relative sensitivity of a lake basin to human activities, and high threat scores *per se* do not necessarily justify management interventions. Such interventions may actually increase biodiversity degradation, noting that many developed countries have already fundamentally degraded their biodiversity because of economic development activities. Thus, activities undertaken to address the Adj-HWS threats may actually degrade the biodiversity status and resources, even if the health and socioeconomic conditions of the lake basin stakeholders are improved as a result of better conditions, thereby increasing stakeholder resource consumption.

The relative Human Development Index (HDI) places the Lake Neusiedler/Fertő basin in a low threat rank in regard to its health, educational and economic conditions.

Table 2. Lake Neusiedler/Fertő Threat Ranks, Based on Multiple Ranking Criteria

(Scores for Adj-HWS, RvBD and HDI ranks are presented in Table 1; the ranks may differ in some cases because of rounding of tied threat scores; Estimated risks: red – highest; orange – moderately high; yellow – medium;
green – moderately low; blue – low)

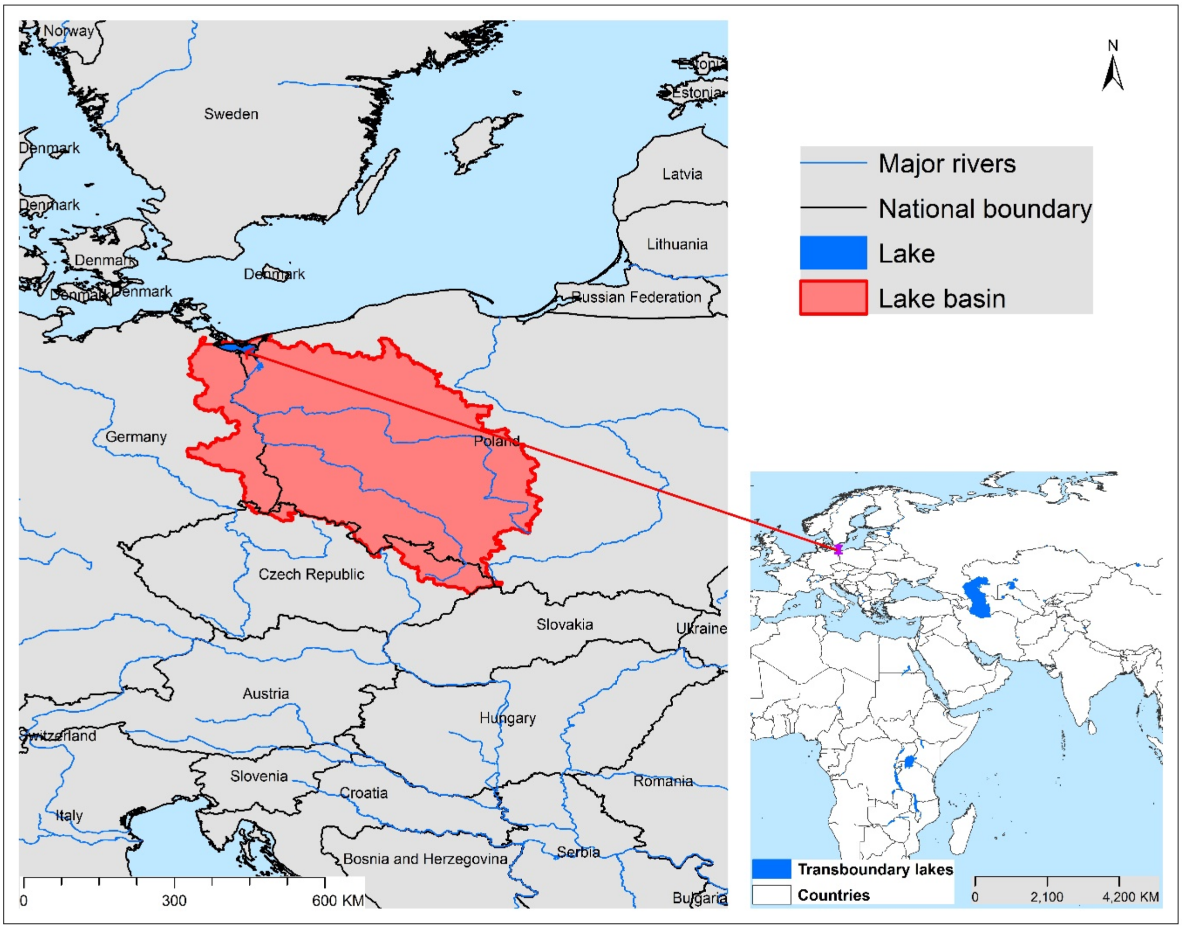
Adj-HWS Rank	HDI Rank	RvBD Rank		Sum Adj-HWS + RvBD	Relative Threat Rank		Sum Adj-HWS + HDI	Relative Threat Rank		Sum Adj-HWS + RvBD + HDI	Overall Threat Rank
42	47	50		92	47		89	45		139	47

When multiple ranking criteria are considered together in the threat rank calculations, the Adj-HWS and HDI scores considered together place Lake Neusiedler/Fertő in the lower quarter of the threat ranks. The relative threat is slightly reduced when the Adj-HWS and RvBD threats are considered together. Considering all three ranking criteria together, Lake Neusiedler/Fertő exhibits a low threat ranking.

Interactions between the ranking parameters for Lake Neusiedler/Fertő indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Lake Neusiedler/Fertő must be considered on the basis of educated judgement and accurate representations of its situation. A fundamental question will be how can one decide a given management intervention will produce the greatest benefit(s) for the greatest number of people in the Lake Neusiedler/Fertő basin? Accurate answers to such questions for Lake Neusiedler/Fertő, and other transboundary lakes, will require a case-by-case assessment approach that considers the specific lake situation and the anticipated improvements from specific management interventions, as well as interactions with water systems to which the lake is linked.

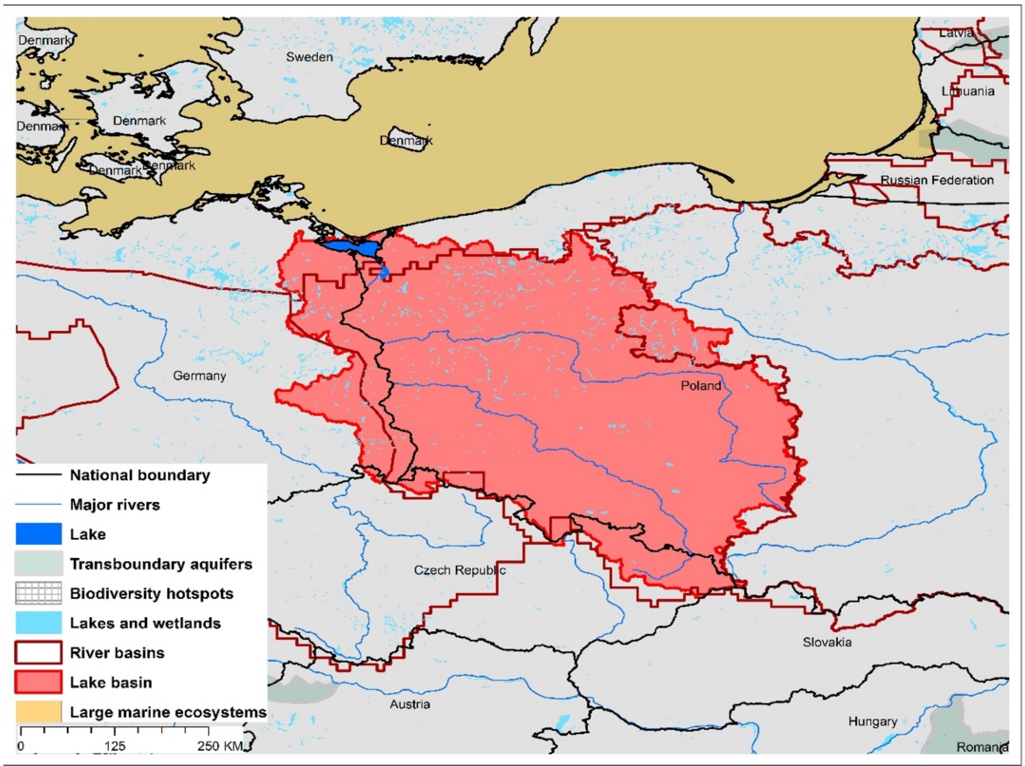
Szczecin Lagoon — Geographic Information

The Szczecin Lagoon is an inland water basin, a lagoon of the Oder River, in the southwestern part of the Baltic Sea, and exhibits the characteristics of a coastal lake. It empties into a bay of the Baltic Sea via three straits that divide the mainland and several islands. The major freshwater inflow is the Oder River. A channel was opened more than a century ago to connect the lagoon with the Baltic Sea for ship passage. The lagoon has been an important fishing grounds for centuries, and has become a tourist destination as well since the 20th Century, offering passenger ship tours, various water sports and some noteworthy beaches. It is currently being threated from pollution from the Oder River, including increased eutrophication.

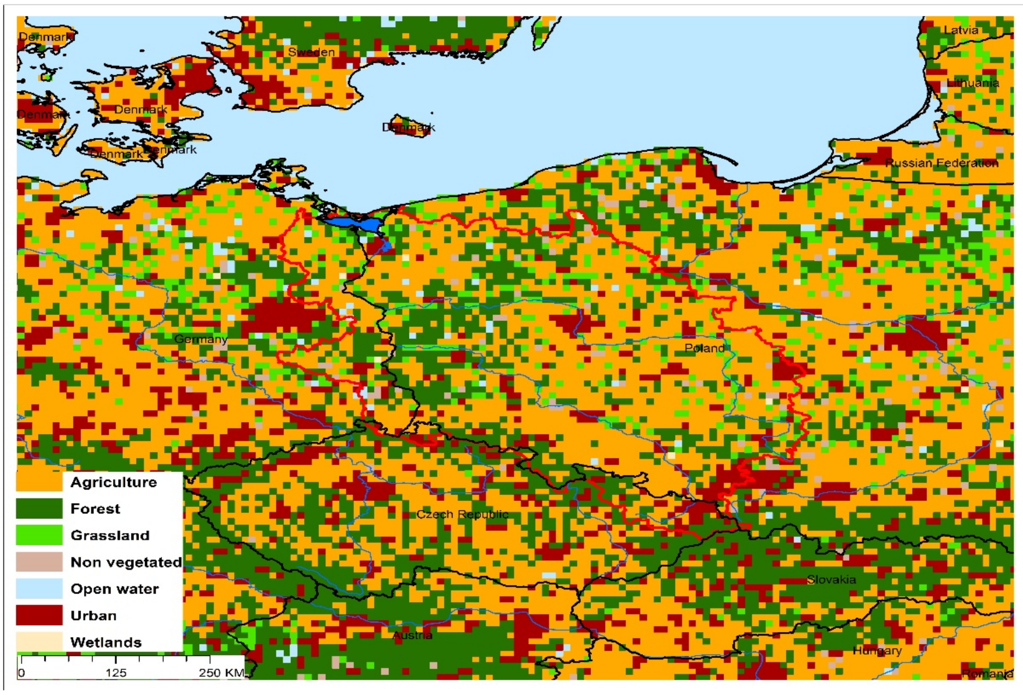


TWAP Regional Designation	Eastern Europe; Northern, Western & Southern Europe	**Lake Basin Population (2010)**	16,862,454
River Basin	Oder	**Lake Basin Population Density (2010; # km^{-2})**	67.1
Riparian Countries	Germany, Poland	**Average Basin Precipitation (mm yr^{-1})**	580.0
Basin Area (km^2)	144,845	**Shoreline Length (km)**	515.9
Lake Area (km^2)	822.4	**Human Development Index (HDI)**	0.83
Lake Area:Lake Basin Ratio	0.006	**International Treaties/Agreements Identifying Lake**	No

Szczecin Lagoon Basin Characteristics



(a) Szczecin Lagoon basin and associated transboundary water systems



(b) Szczecin Lagoon basin land use

Szczecin Lagoon Threat Ranking

A serious lack of global-scale uniform data on the TWAP transboundary in-lake conditions required their potential threat risks be estimated on the basis of the characteristics of their drainage basins, rather than in-lake conditions. Using basin characteristics to rank transboundary lake threats precludes consideration of the unique features that can buffer their in-lake responses to basin-derived disturbances, including an integrating nature for all inputs, long water retention times, and complex, non-linear response dynamics.

The lake threat ranks were calculated with a spreadsheet-based interactive scenario analysis program, incorporating data and information about the nature and magnitude of their basin-derived stresses, and their possible impacts on the sustainability of their ecosystem services. These descriptive data for Szczecin Lagoon and the other transboundary lakes included lake and basin areas, population numbers and densities, areal extent of basin stressors on the lake, data grid size, and other components considered important from the perspective of the user of the data results. The scenario analysis program also provides a means to define the appropriate context and preconditions for interpreting the ranking results.

The Szczecin Lagoon threat ranks are expressed in terms of the Adjusted Human Water Security (Adj-HWS) threats, Reverse Biodiversity (RvBD) threats, and the Human Development Index (HDI) score, as well as combinations of these indices. However, it is emphasized that, being based on specific characteristics and assumptions regarding Szczecin Lagoon and its basin characteristics, the calculated threat scores represent only one possible set of lake threat rankings. Defining the appropriate context and preconditions for interpreting the lake rankings remains an important responsibility of those using the threat ranking results, including lake managers and decision-makers.

Table 1. Szczecin Lagoon Relative Threat Ranks, Based on Adjusted Human Water Security (Adj-HWS) and Reverse Biodiversity Threats, and Human Development Index (HDI) Score

(Estimated risks: red – highest; orange – moderately high; yellow – medium; green – moderately low; blue – low)

Adjusted Human Water Security (Adj-HWS) Threat Score	Relative Adj-HWS Threat Rank		Reverse Biodiversity (RvBD) Threat Score	Relative RvBD Threat Rank		Human Development Index (HDI) Score	Relative HDI Rank
0.53	**43**		**0.49**	**43**		**0.85**	**44**

It is emphasized that the Szczecin Lagoon rankings above are discussed here within the context of the management and decision-making process, rather than as strict numerical ranks. Based on its geographic, population and socioeconomic assumptions used in the scenario analysis program, the calculated Adj-HWS score for Szczecin Lagoon indicates a low threat rank compared to other priority transboundary lakes.

The Reverse Biodiversity (RvBD) for Szczecin Lagoon, which is meant to describe its biodiversity sensitivity to basin-derived degradation, places the lake in a moderately low threat rank, compared to the other transboundary lakes. Management interventions directed to improving the biodiversity status must be viewed with caution, however, since we lack sufficient knowledge and experience to accurately predict the ultimate impacts of biodiversity manipulations and preservation efforts. Further, the RvBD scores indicate the relative sensitivity of a lake basin to human activities, and high threat scores *per se* do not necessarily justify management interventions. Such interventions may actually increase biodiversity degradation, noting that many developed countries have already fundamentally degraded their biodiversity because of economic development activities. Thus, activities undertaken to address the Adj-HWS threats may actually degrade the biodiversity status and resources, even if the health and socioeconomic conditions of the lake basin stakeholders are improved as a result of better conditions, thereby increasing stakeholder resource consumption.

The relative Human Development Index (HDI) places the Szczecin Lagoon basin in a low threat rank in regard to its health, educational and economic conditions.

Table 2. Szczecin Lagoon Threat Ranks, Based on Multiple Ranking Criteria

(Scores for Adj-HWS, RvBD and HDI ranks are presented in Table 1; the ranks may differ in some cases because of rounding of tied threat scores; Estimated risks: red – highest; orange – moderately high; yellow – medium;
green – moderately low; blue – low)

Adj-HWS Rank	HDI Rank	RvBD Rank		Sum Adj-HWS + RvBD	Relative Threat Rank		Sum Adj-HWS + HDI	Relative Threat Rank		Sum Adj-HWS + RvBD + HDI	Overall Threat Rank
43	43	43		86	44		86	43		129	45

When multiple ranking criteria are considered together in the threat rank calculations, the Adj-HWS and HDI scores considered together place Szczecin Lagoon in the lower quarter of the threat ranks. The relative threat is similar when the Adj-HWS and RvBD threats are considered together. Considering all three ranking criteria together, Szczecin Lagoon exhibits a low threat ranking.

Interactions between the ranking parameters for Szczecin Lagoon indicate differing sensitivity to basin-derived stresses. Identifying potential management interventions needs for Szczecin Lagoon must be considered on the basis of educated judgement and accurate representations of its situation. A fundamental question will be how can one decide a given management intervention will produce the greatest benefit(s) for the greatest number of people in the Szczecin Lagoon basin? Accurate answers to such questions for Szczecin Lagoon, and other transboundary lakes, will require a case-by-case assessment approach that considers the specific lake situation and the anticipated improvements from specific management interventions, as well as interactions with water systems to which the lake is linked.

METHODOLOGY AND CAVEATS REGARDING TRANSBOUNDARY LAKE THREAT RANKS

A serious lack of global-scale uniform data on the TWAP transboundary in-lake conditions required their potential risks be estimated on the basis of the characteristics of their drainage basins, rather than analysis of their in-lake conditions. The lake threat ranks were calculated with a scenario analysis program that allowed incorporation of specific assumptions and preconditions about the nature and magnitude of their basin-derived stresses, and their possible impacts on the sustainability of their ecosystem services, as defined by the user of the ranking results. Because the transboundary lake threat ranks are based on specific lake and basin assumptions, therefore, the calculated rankings represent only one possible set of lake rankings.

Using basin characteristics to rank transboundary lake threats precludes consideration of the unique features that can buffer their in-lake responses to basin-derived disturbances, including an integrating nature for all inputs, long water retention times, and complex, non-linear response dynamics. A global overview of river basin threats based on 23 basin-scale drivers under four thematic areas (catchment disturbance; pollution; water resource development; biotic factors) was modified for the transboundary lakes assessment. The driver weights were initially based on collective opinions of experts exhibiting a range of disciplinary expertise, subsequently being refined with inputs from lake scientists and managers participating in ILEC's 15th World Lake Conference.

A spreadsheet-based, interactive scenario analysis program was used to rank the transboundary lake threats. The lake basin characteristics were determined by superimposing the lake basins over the river basin grids, and scaling the driver data to lake basin scale. Selected basin drivers, weights and preconditions were used in the scenario analysis program to calculate the relative lake threat ranks, expressed in terms of the Incident (HWS) and Adjusted (Adj-HWS) Human Water Security and Incident Biodiversity (BD) threats.

The transboundary lake analyses incorporated several assumptions and preconditions. Small transboundary lakes (area <5 km^2), sparse basin populations (< 5 persons km^{-1}), or that were frozen over for major portions of the year (annual air temperature <5 ^{o}C), were eliminated from the analyses. The areal extent of the influences of the basin drivers was addressed with a sensitivity analysis that indicated an areal band of 100 km^2 around a lake, appropriately clipped for the surrounding basin, was a realistic upper boundary for the scenario analysis program. The river basin grid size was problematic in that some grids (30' grid [0.5^o]) were often larger than those of some transboundary lake basins, and about 10% of the transboundary lakes lacked driver data for some grids. Based on these considerations, a final list of 53 priority transboundary lakes was selected for the scenario analysis program calculations of relative threat scores.

Insights obtained from lake scientists and managers participating in the 15th World Lake Conference helped address some of these concerns. Region-specific lake questionnaires also were distributed in some cases, obtaining both quantitative and qualitative data regarding the transboundary lakes and their basins.

These various factors and concerns indicate the transboundary lake threat ranks must be considered within the context of the specific basin conditions and assumptions used to derive them, since they represent only one possible set of lake threat rankings. Other factors such as lake and basin area, basin population and density, regional location, per capita Gross National Income (GNI), and Human

Development Index (HDI) could produce markedly different ranking results. Defining the appropriate context and preconditions for interpreting the lake ranking results, a task beyond the scope of this analysis, remains an important responsibility of those using the results, including lake managers and decision-makers.

The calculated ranks of the priority transboundary lakes, based on the specific assumptions and preconditions regarding the lakes and their drainage basins, is expressed below in terms of Adjusted Human Water Security (Adj-HWS) threats, Reverse Biodiversity (RvBD) threats, and Human Development Index (HDI) status. The Incident Human Water Security (HWS) score would suggest the current threat ranks of the lakes. However, for identifying needed management interventions, the ability of the basin countries to undertake investments to reduce identified transboundary water threats (i.e., water supply stabilization, improved water services, etc.) is also a relevant factor. This ability is considered within the context of the Adj-HWS threat. Countries less able to make such investments, mainly developing countries, exhibited higher Adj-HWS threats. Thus, the Adj-HWS threat ranks provide a more realistic picture of the transboundary lakes most in need of catalytic funding for management interventions than those with lower Adj-HWS scores.

Our more limited knowledge and experience regarding the ultimate outcomes of ecosystem restoration and conservation activities precluded a BD metric identical to the Adj-HWS threat. The Adj-HWS threat rank is meant to identify the transboundary lakes in most need of management interventions from a water investment perspective. The native biodiversity of most developed countries, however, has already been largely degraded as a result of their economic development activities. Thus, the preservation of those ecosystems still exhibiting the most pristine or undisturbed conditions should be the major BD management intervention goal. To address this goal, a RvBD threat was developed as a BD surrogate to define relative BD threats. It was calculated as 1-BD score, with the resulting RvBD score indicating the relative 'pristineness' of a lake in regard to its biodiversity status. The higher RvBD scores calculated with this normalization procedure identify the transboundary lakes most likely to be sensitive to BD degradation and, therefore, the lakes most in need of management attention.

The Human Development Index (HDI) is a composite statistic used by the United Nations Development Programme (UNDP) to reflect the relative life expectancy, education level, and per capita income of a country. A country whose inhabitants exhibit longer life spans, higher education levels, and higher per capita GDPs typically exhibit higher HDI scores, suggesting a higher overall condition of its citizens. It is meant to indicate that economic growth alone is not the sole criteria to assessment of a country, but that the status of its citizens and their capabilities also are important defining factors, therefore being an indication of potential human development.

Along with the assumptions and preconditions defining specific lake basin characteristics, these three criteria were major indicators considered within the context of the scenario analysis program to calculate the relative threat ranks of the transboundary lakes, as presented in the transboundary lake profile sheets.

Transboundary Lakes Ranked on Basis of (a) Incident Human Water Security [HWS] Threats, (b) Adjusted Human Water Security [Adj-HWS] Threats, and (c) Incident Biodiversity [BD] Threats

(Cont., continent; Eur, Europe; N.Am, North America; Afr., Africa; S.Am, South America; Estimated risks: red – highest; orange – moderately high; yellow – medium; green – moderately low; blue – low)

(A) Lakes Ranked on Basis of Adjusted Human Water Security (Adj-HWS) Threats

Lake	Cont.	Surface Area (km^2)	Adj-HWS Threat Score	Rank
Sistan	Asia	488.2	0.98	1
Ihema	Afr.	93.2	0.97	2
Azuei	S.Am	117.3	0.96	3
Rweru/Moero	Afr.	125.6	0.96	4
Cohoha	Afr.	64.8	0.96	5
Edward	Afr.	2232.0	0.94	6
Natron/Magadi	Afr.	560.4	0.93	7
Abbe/Abhe	Afr.	310.6	0.93	8
Victoria	Afr.	66841.5	0.91	9
Albert	Afr.	5502.3	0.91	10
Kivu	Afr.	2371.1	0.91	11
Malawi/Nyasa	Afr.	29429.2	0.91	12
Dead Sea	Eur	642.7	0.90	13
Turkana	Afr.	7439.2	0.90	14
Aras Su Qovsaginin Su Anbari	Asia	52.1	0.89	15
Mangla	Asia	85.4	0.87	16
Galilee	Eur	162.0	0.87	17
Darbandikhan	Asia	114.3	0.87	18
Selingue	Afr.	334.4	0.87	19
Shardara/Kara-Kul	Asia	746.1	0.86	20
Nasser/Aswan	Afr.	5362.7	0.86	21
Chilwa	Afr.	1084.2	0.86	22
Josini/Pongola-poort Dam	Afr.	128.6	0.85	23

(B) Lakes Ranked on Basis of Reverse Biodiversity (RvBD) Threats

Lake	Cont.	Surface area (km^2)	RvBD Threat Score	Rank
Lake Congo River	Afr.	306.0	0.80	1
Sarygamysh	Asia	3777.7	0.75	2
Chiuta	Afr.	143.3	0.74	3
Mweru	Afr.	5021.5	0.72	4
Aral Sea	Asia	23919.3	0.72	5
Tanganyika	Afr.	32685.5	0.71	6
Abbe/Abhe	Afr.	310.6	0.71	7
Titicaca	S.Am	7480.0	0.71	8
Chilwa	Afr.	1084.2	0.70	9
Salto Grande	S.Am	532.9	0.70	10
Turkana	Afr.	7439.2	0.70	11
Cahora Bassa	Afr.	4347.4	0.69	12
Chungarkkota	S.Am	52.6	0.69	13
Malawi/Nyasa	Afr.	29429.2	0.68	14
Nasser/Aswan	Afr.	5362.7	0.68	15
Selingue	Afr.	334.4	0.68	16
Kivu	Afr.	2371.1	0.67	17
Natron/Magadi	Afr.	560.4	0.67	18
Lago de Yacyreta	S.Am	1109.4	0.66	19
Kariba	Afr.	5258.6	0.66	20
Edward	Afr.	2232.0	0.65	21
Aby	Afr.	438.8	0.65	22
Chad	Afr.	1294.6	0.64	23

(C) Lakes Ranked on Basis of Human Development Index (HDI) Scores

Lake	Cont.	Surface area (km^2)	HDI Score	Rank
Lake Congo River	**Afr**	**306.0**	**0.34**	**1**
Selingue	**Afr**	**334.4**	**0.36**	**2**
Rweru/Moero	**Afr**	**125.6**	**0.36**	**3**
Cohoha	**Afr**	**64.8**	**0.38**	**4**
Kivu	**Afr**	**2371.1**	**0.38**	**5**
Mweru	**Afr**	**5021.5**	**0.38**	**6**
Abbe/Abhe	**Afr**	**310.6**	**0.40**	**7**
Tanganyika	**Afr**	**32685.5**	**0.40**	**8**
Turkana	**Afr**	**7439.2**	**0.41**	**9**
Chiuta	**Afr**	**143.3**	**0.41**	**10**
Chilwa	**Afr**	**1084.2**	**0.41**	**11**
Malawi/Nyasa	**Afr**	**29429.2**	**0.42**	**12**
Edward	**Afr**	**2232.0**	**0.43**	**13**
Nasser/Aswan	**Afr**	**5362.7**	**0.43**	**14**
Cahora Bassa	**Afr**	**4347.4**	**0.43**	**15**
Chad	**Afr**	**1294.6**	**0.43**	**16**
Kariba	**Afr**	**5358.6**	**0.43**	**17**
Ihema	**Afr**	**93.2**	**0.44**	**18**
Sistan	**Asia**	**488.2**	**0.46**	**19**
Albert	**Afr**	**5502.3**	**0.46**	**20**
Azuei	**S.Am,**	**117.3**	**0.46**	**21**
Victoria	**Afr**	**66841.5**	**0.47**	**22**
Natron/Magadi	**Afr**	**560.4**	**0.51**	**23**

	Afr.	143.3	0.85	24		Albert	Afr.	5502.3	0.63	24		**Aby**	**Afr**	**438.8**	**0.52**	**24**
Chad	Afr.	1294.6	0.84	25		Sistan	Asia	488.2	0.62	25		**Mangla**	**Asia**	**85.4**	**0.54**	**25**
Aral Sea	Asia	23919.3	0.84	26		Amistad	N.Am	131.3	0.61	26		**Aral Sea**		**23919.3**	**0.60**	**26**
Tanganyika	Afr.	32685.5	0.84	27		Caspian Sea	Asia	377543.2	0.60	27		**Josini/Pongola-poort Dam**	**Afr**	**128.6**	**0.61**	**27**
Aby	Afr.	438.8	0.83	28		Cohoha	Afr.	64.8	059	28		**Shardara/Kara-kul**	**Asia**	**746.1**	**0.65**	**28**
Cahul	Eur	89.0	0.82	29		Itaipu	S.Am	1154.1	0.58	29		**Sarygamysh**	**Asia**	**3777.7**	**0.67**	**29**
Chungarkkota	S.Am	52.6	0.82	30		Rweru/Moero	Afr.	125.6	0.58	30		**Darbandikhan**	**Asia**	**114.3**	**0.68**	**30**
Titicaca	S.Am	7480.0	0.82	31		Azuei	S.Am	117.3	0.57	31		**Cahul**	**Eur**	**89.0**	**0.69**	**31**
Sarygamysh	Asia	3777.7	0.82	32		Ihema	Afr.	93.2	0.56	32		**Titicaca**	**S.Am**	**7480.0**	**0.71**	**32**
Mweru	Afr.	5021.5	0.81	33		Victoria	Afr.	66841.5	0.56	33		**Chungarkkota**	**S.Am**	**52.6**	**0.71**	**33**
Cahora Bassa	Afr.	4347.4	0.78	34		Scutari/Skadar	Eur	381.5	0.55	34		**Dead Sea**	**Eur**	**642.7**	**0.72**	**34**
Itaipu	S.Am	1154.1	0.75	35		Shardara/Kara-Kul	Asia	746.1	0.54	35		**Lago de Yacyreta**	**S.Am**	**1109.4**	**0.73**	**35**
Kariba	Afr.	5258.6	0.75	36		Huron	N.Am	60565.2	0.53	36		**Aras Su Qovsaginin Su Anbari**	**Asia**	**52.1**	**0.73**	**36**
Lago de Yacyreta	S.Am	1109.4	0.75	37		Josini/Pongola-poort Dam	Afr.	128.6	0.52	37		**Itaipu**	**S.Am**	**1154.1**	**0.73**	**37**
Lake Congo River	Afr.	306.0	0.75	38		Champlain	N.Am	1098.9	0.51	38		**Salto Grande**	**S.Am**	**532.9**	**0.74**	**38**
Caspian Sea	Asia	377543.2	0.73	39		Ohrid	Eur	354.3	0.51	39		**Ohrid**	**Eur**	**354.3**	**0.74**	**39**
Salto Grande	S.Am	532.9	0.67	40		Macro Prespa	Eur	263.0	0.51	40		**Macro Prespa**	**Eur**	**263.0**	**0.75**	**40**
Scutari/Skadar	Eur	381.5	0.62	41		Dead Sea	Eur	642.7	0.51	41		**Caspian Sea**	**Asia**	**377543.2**	**0.77**	**41**
Neusiedler/Ferto	Eur	141.9	0.58	42		Maggiore	Eur	211.4	0.49	42		**Scutari/Skadar**	**Eur**	**381.5**	**0.78**	**42**
Szczecin Lagoon	Eur	822.4	0.53	43		Szczecin Lagoon	Eur	822.4	0.49	43		**Szczecin Lagoon**	**Eur**	**822.4**	**0.83**	**43**
Erie	N.Am	26560.8	0.51	44		Ontario	N.Am	19062.2	0.47	44		**Falcon**	**N.Am**	**120.6**	**0.85**	**44**
Macro Prespa)	Eur	263.0	0.51	45		Aras Su Qovsaginin Su Anbari	Asia	52.1	0.47	45		**Amistad**	**N.Am**	**131.3**	**0.86**	**45**
Falcon	N.Am	120.6	0.50	46		Darbandikhan	Asia	114.3	0.46	46		**Galilee**	**Eur**	**162.0**	**0.88**	**46**
Amistad	N.Am	131.3	0.49	47		Galilee	Eur	162.0	0.45	47		**Neusiedler/Ferto**	**Eur**	**141.9**	**0.88**	**47**
Ontario	N.Am	19062.2	0.48	48		Michigan	N.Am	58535.5	0.44	48		**Lake Maggiore**	**Eur**	**211.4**	**0.89**	**48**
Ohrid	Eur	354.3	0.47	49		Erie	N.Am	26560.8	0.43	49		**Ontario**	**N.Am**	**19062.2**	**0.92**	**49**
Michigan	N.Am	58535.5	0.44	50		Neusiedler/Ferto	Eur	141.9	0.39	50		**Huron**	**N.Am**	**60565.2**	**0.93**	**50**
Huron	N.Am	60565.2	0.42	51		Cahul	Eur	89.0	0.39	51		**Erie**	**N.Am**	**26560.8**	**0.93**	**51**
Maggiore	Eur	211.4	0.33	52		Mangla	Asia	85.4	0.38	52		**Champlain**	**N.Am**	**1098.9**	**0.94**	**52**
Champlain	N.Am	1098.9	0.29	53		Falcon	N.Am	120.6	0.38	53		**Michigan**	**N.Am**	**58535.5**	**0.94**	**53**

Transboundary Lake Threat Ranks by Multiple Ranking Criteria

(Cont., continent; Eur, Europe; N.Am, North America; Afr, Africa; S.Am, South America; Adj-HWS, Adjusted Human Water Security threat; HWS, Incident Human Water Security threat; BD, Incident Biodiversity threat; HDI, Human Development Index, RvBD, surrogate for 'Adjusted' Biodiversity threat; Estimated risks: Red – highest; Orange – moderately high; Yellow – medium; Green – moderately low; Blue – low)

Cont.	Lake Name	Adj-HWS Threat	RvBD Threat	HDI	Adj-HWS Rank	HDI Rank	RvBD Rank	Sum Adj-HWS + RvBD	Relative Rank	Sum Adj-HWS + HDI	Relative Rank	Sum Adj-HWS + RvBD + HDI	Overall Rank
Afr	Abbe/Abhe	0.93	0.71	0.40	7	7	7	14	1	14	3	21	1
Afr	Turkana	0.90	0.70	0.41	13	10	9	22	2	23	10	32	2
Afr	Selingue	0.87	0.68	0.36	16	2	15	31	11	18	5	33	3
Afr	Malawi/Nyasa	0.91	0.68	0.42	9	12	14	23	3	21	9	35	4
Afr	Chiuta	0.85	0.74	0.41	23	9	3	26	5	32	15	35	4
Afr	Cohoha	0.96	0.59	0.38	3	4	28	31	2	7	1	35	4
Afr	Kivu	0.91	0.67	0.38	12	6	18	30	8	18	4	36	7
Afr	Rweru/Moero	0.96	0.58	0.36	4	3	30	34	16	7	2	37	8
Afr	Lake Congo River	0.75	0.78	0.34	35	1	1	36	18	36	19	37	8
Afr	Tanganyika	0.84	0.71	0.40	26	8	6	32	14	34	17	40	10
Afr	Edward	0.94	0.65	0.43	6	13	22	28	7	19	6	41	11
Afr	Chilwa	0.86	0.70	0.41	21	11	10	31	10	32	14	42	12
Afr	Mweru	0.81	0.72	0.38	33	5	4	37	21	38	20	42	12
Asia	Sistan	0.98	0.62	0.46	1	20	25	26	6	21	8	46	14
Afr	Natron/Magadi	0.93	0.67	0.51	8	23	17	25	4	31	13	48	15
Afr	Nasser/Aswan	0.86	0.68	0.43	20	16	16	36	19	36	18	52	16
Afr	Albert	0.91	0.63	0.46	10	19	24	34	15	29	12	53	17
Afr	Ihema	0.97	0.56	0.44	2	18	33	35	17	20	7	53	17
S.Am,	Azuei	0.96	0.57	0.46	5	21	31	36	20	26	11	57	19
Asia	Aral Sea	0.84	0.62	0.60	27	26	5	32	13	53	31	58	20
Asia	Sarygamysh	0.82	0.75	0.67	29	29	2	31	9	58	32	60	21
Afr	Cahora Bassa	0.78	0.69	0.43	34	15	13	47	25	49	25	62	22
Afr	Victoria	0.91	0.56	0.47	11	22	32	43	24	33	16	65	23
Afr	Chad	0.84	0.64	0.43	25	17	23	48	26	42	21	65	23
Afr	Kariba	0.75	0.66	0.43	36	14	19	55	30	50	28	69	25

S.Am	Titicaca	0.82	0.71	0.71	32	32	8	40	22	25	35	72	26
Afr	Aby	0.83	0.65	0.52	28	24	21	49	27	52	30	73	27
S.Am	Chungarkkota	0.82	0.69	0.71	31	33	12	43	23	64	34	76	28
Asia	Shardara/Kara-kul	0.86	0.54	0.65	22	28	35	57	31	50	27	85	29
Eur	Dead Sea	0.90	0.51	0.72	14	34	38	52	29	48	24	86	30
Afr	Josini/Pongola-poort Dam	0.85	0.52	0.61	24	27	37	61	34	51	29	88	31
S.Am	Salto Grande	0.67	0.70	0.74	40	38	11	51	28	78	39	89	32
Asia	Darbandikhan	0.87	0.46	0.68	17	30	46	63	35	47	23	93	33
S.Am	Lago de Yacyreta	0.75	0.66	0.73	38	36	20	58	32	74	38	94	34
Asia	Aras Su Qovsaginin Su Anbari	0.89	0.47	0.73	15	35	44	59	33	50	26	94	34
Asia	Mangla	0.87	0.38	0.54	18	25	53	71	39	43	22	96	36
S.Am	Itaipu	0.75	0.58	0.73	37	37	29	66	37	74	37	103	37
Asia	Caspian Sea	0.73	0.60	0.77	39	41	27	66	36	80	40	107	38
Eur	Galilee	0.87	0.45	0.88	19	46	47	66	38	65	36	112	39
Eur	Cahul	0.82	0.39	0.69	30	31	51	81	42	61	33	112	39
Eur	Scutari/Skadar	0.62	0.55	0.78	41	42	34	75	41	83	41	117	41
N.Am	Amistad	0.49	0.61	0.86	47	45	26	73	40	47	40	118	42
Eur	Macro Prespa (Large Prespa)	0.51	0.51	0.75	44	40	40	84	43	84	42	124	43
Eur	Ohrid	0.47	0.51	0.74	49	39	39	88	46	88	44	127	44
Eur	Szczecin Lagoon	0.53	0.49	0.83	43	43	43	86	44	86	43	129	45
N.Am	Huron	0.42	0.53	0.93	51	50	36	87	45	101	51	137	46
Eur	Neusiedler/Ferto	0.58	0.39	0.88	42	47	50	92	47	89	45	139	47
N.Am	Ontario	0.48	0.47	0.92	48	49	45	93	48	97	49	142	48
Eur	Lake Maggiore	0.33	0.50	0.89	52	48	42	94	50	100	50	142	48
N.Am	Falcon	0.50	0.38	0.85	46	44	52	98	53	90	46	142	48
N.Am	Erie	0.51	0.43	0.93	45	51	49	94	51	96	48	145	51
N.Am	Champlain	0.29	0.51	0.94	53	52	41	94	49	105	53	146	52
N.Am	Michigan	0.44	0.44	0.94	50	53	48	98	52	103	52	151	53

Jeff Schmaltz, MODIS Rapid Response Team, NASA/GSFC

1. Amur
2. Danube
3. Daugava
4. Dnieper
5. Dniester
6. Don
7. Elancik
8. Elbe
9. Har Us Nur
10. Jacobs
11. Jenisej/ Yenisey
12. Kemi
13. Kogilnik
14. Kura-Araks
15. Lake Ubsa-Nur
16. Lava/ Pregel
17. Maritsa
18. Mius
19. Narva
20. Neman
21. Nestos
22. Ob
23. Oder/ Odra
24. Olanga
25. Oral/ Ural
26. Oulu
27. Pasvik
28. Prohladnaja
29. Psou
30. Rezvaya
31. Samur
32. Sarata
33. Struma
34. Sujfun
35. Sulak
36. Terek
37. Tuloma
38. Tumen
39. Vardar
40. Velaka
41. Vistula/ Wista
42. Volga
43. Vuoksa

Amur Basin

Geography

Total drainage area (km^2)	2,092,690
No. of countries in basin	4
BCUs in basin	China (CHN), Dem People's Rep of Korea (PRK), Mongolia (MNG), Russian Federation (RUS)
Population in basin (people)	65,216,853
Country at mouth	Russian Federation
Average rainfall (mm/year)	521

Governance

No. of treaties and agreements[1]	5
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	32
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
AMUR_CHN		115.56			4,656.10	29.73
AMUR_MNG		20.01			746.14	5.34
AMUR_PRK						
AMUR_RUS		251.83			8,275.46	85.26
Total in Basin	363.74	173.81			13,677.70	120.33

Water Withdrawals

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

BCU	Total (km3/year)	Irrigation (km3/year)	Livestock (km3/year)	Electricity (km3/year)	Manufacture (km3/year)	Domestic (km3/year)	Per capita (m3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
AMUR_CHN	24,959.08	18,014.52	229.48	2,860.12	1,564	2,291.36	403.74	
AMUR_MNG								
AMUR_PRK								
AMUR_RUS	1,211.15	167.84	18.09	409.49	185	430.91	373.40	
Total in Basin	26,466.22	18,275.37	257.29	3,454.35	1,749.01	2,730.21	405.82	7.28

Socioeconomic Geography

BCU	Area ('000 km2)	BCU area in basin (%)	Population ('000 people)	Population density (people/km2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km2)
AMUR_CHN	889	0.42	61,820	69.53	0.51	0.02	99.98	52	6,807.43	5	5.62
AMUR_MNG	195	0.09	152	0.97	1.58	44.50			2,286.00	0	0.00
AMUR_PRK	0	0.00	1	21.11				0	0.00	0	0.00
AMUR_RUS	1,008	0.48	3,244	3.22	-0.12	0.00	100.00	4	14,611.70	1	0.99
Total in Basin	2,093	1.00	65,217	31.16	0.48	0.02	99.98	56	7,189.04	6	2.87

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
AMUR_CHN	2	4	3		5	2	3	3	4	2	3	2	1	2	3
AMUR_MNG	2	4	2		5	4	2	2	4	2	3	5	1	2	4
AMUR_PRK					5	2			3	5	3	4	1	3	1
AMUR_RUS	2	1	2		4	2	2	3	4	3	4	2	1	2	3
River Basin	2	2	2	3	5	2	2	3	4	2	3	2	1	2	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
AMUR_CHN	3	3	4	5			1	1	3
AMUR_MNG	4	4	4	4			2	2	3
AMUR_PRK									3
AMUR_RUS	3	3	1	1			1	1	4
River Basin	3	3	2	3	3	4	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	2				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

Disclaimer

The results and information of factsheet is produced and maintained by the River Basins Component of the GEF Transboundary Water Assessment Programme (GEF TWAP).

GEF TWAP is the first global-scale assessment of all transboundary water systems. The TWAP consists of five independent indicator-based water system assessments and the linkages between them, including their socioeconomic and governance-related features. The United Nations Environment Programme (UNEP) is the implementing agency of TWAP. Project Coordination Unit (PCU) in Nairobi, Kenya coordinates the work of UNESCO-IHP, ILEC, UNEP-DHI and the IOC of UNESCO on Transboundary Aquifers, Lake Basins, River Basins, Large Marine Ecosystems and Open Ocean respectively. Each executing partner engages a broad network of data and information rich partners with responsibilities either of a thematic or geographic nature. More on TWAP full size project at http://www.geftwap.org .

The TWAP River Basins component (TWAP RB) carried out a global comparison of 286 transboundary river basins, in order to enable the prioritisation of funds for basins at risk from a variety of issues, covering water quantity, water quality, ecosystems, governance and socio-economics. It also considered risks to deltas from threats of a transboundary nature, and considered the relative influence of lakes on these river basins. TWAP RB is an indicator–based assessment, allowing for an analysis of basins, based on risks to both societies and ecosystems. It also includes provisional outlook projections to 2030 and 2050 for a limited number of indicators.
Values given in the present fact-sheet represent an approximate guide only and should not replace recent local assessments.

Country Boundaries Under TWAP
TWAP RB assessment uses country delineations provided by FAO GAUL (Global Administrative Unit Layers) (FAO 2014). GAUL uses the International Boundary dataset of the UNCS (UN Cartographic Section) and inland boundaries are same for both datasets. Some differences occur in coastlines, where FAO GAUL dataset offers more detail.

Disputed areas
The GAUL project and original dataset maintains disputed areas in such a way to preserve national integrity for all disputing countries. The GAUL Set reports the international, first level and second level administrative boundaries delimiting, or falling within, the disputed areas in a way to enable the re-construction of the administrative units as they are specified by the individual disputing countries. Disputed areas are therefore shown as individual entities, not dependent from countries, with corresponding coding. Same approach has been taken by TWAP RB, reporting on disputed territories, as well as presentation of Basin Country Units.

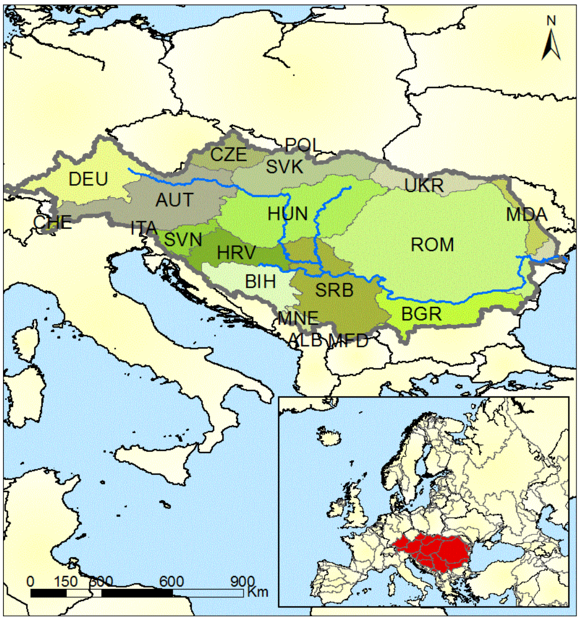
Basin Delineation
TWAP RB assessment includes 286 transboundary river basins. Information on this layer and delineation methodology can be retrieved by downloading metadata sheet for the Basins layer from TWAP Rivers Data Portal at http://twap-rivers.org/indicators/ or by direct download from http://twap-rivers.org/assets/Basin%20and%20BCU%20Creation%20Documentation.pdf

For more information on data sources, indicator calculation methodologies, limitations and more consult indicator metadata sheets available on TWAP RB Data portal on http://twap-rivers.org . To view sources of data included in this Factsheet download the Factsheet Reference file at http://twap-rivers.org/assets/Factsheet_template_with_references.pdf.

For more information on data sources, indicator calculation methodologies, limitations and more consult indicator metadata sheets available on TWAP RB Data portal on http://twap-rivers.org .

Jesse Allen & Robert Simon using EO-1 ALI data courtesy of the NASA EO-1 team and the US Geological Survey

Danube Basin



Geography

Total drainage area (km²)	796,498
No. of countries in basin	19
BCUs in basin	Albania (ALB), Austria (AUT), Bosnia And Herzegovina (BIH), Bulgaria (BGR), Croatia (HRV), Czech Republic (CZE), Germany (DEU), Hungary (HUN), Italy (ITA), Moldova, Republic Of (MDA), Montenegro (MNE), Poland (POL), Romania (ROM), Serbia (SRB), Slovakia (SVK), Slovenia (SVN), Switzerland (CHE), The former Yugoslav Republic of Macedonia (MFD), Ukraine (UKR)
Population in basin (people)	80,184,793
Country at mouth	Romania
Average rainfall (mm/year)	792

Governance

No. of treaties and agreements[1]	37
No. of RBOs and Commissions[2]	5

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	12
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
DANU_ALB						
DANU_AUT		515.35			153.38	0.15
DANU_BGR		159.68				
DANU_BIH		420.02				
DANU_CHE		764.81				

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

DANU_CZE		150.85				
DANU_DEU		474.03			134.10	5.00
DANU_HRV		403.04				
DANU_HUN		118.16			711.52	1.87
DANU_ITA		465.01				
DANU_MDA		173.09			1.88	0.00
DANU_MFD						
DANU_MNE		903.63				
DANU_POL						
DANU_ROM		194.51			159.39	0.67
DANU_SRB		168.69			11.61	0.07
DANU_SVK		251.64				
DANU_SVN		642.53				
DANU_UKR		289.26			427.12	0.79
Total in Basin	221.76	278.42			1,599.00	8.55

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
DANU_ALB								
DANU_AUT	5,551.14	320.09	56.76	1,680.97	2,871	622.13	728.69	
DANU_BGR	4,825.91	1,506.69	13.66	2,297.04	575	433.19	1,440.13	
DANU_BIH	599.45	24.48	8.66	341.30	43	181.54	193.79	
DANU_CHE	6.81	0.28	0.26	0.00	0	6.27	300.34	
DANU_CZE	548.43	78.67	11.01	50.20	219	189.57	200.93	
DANU_DEU	3,323.59	43.69	73.33	1,975.94	674	556.61	336.81	
DANU_HRV	883.67	74.57	13.04	497.27	107	191.37	315.87	
DANU_HUN	6,725.28	1,084.25	38.42	4,285.69	515	801.83	707.92	
DANU_ITA	109.62	26.51	2.22	10.32	6	64.23	6,264.83	
DANU_MDA	381.16	288.38	4.87	0.00	32	55.99	363.77	
DANU_MFD								
DANU_MNE	228.47	0.66	1.96	183.54	4	38.78	631.98	
DANU_POL								
DANU_ROM	21,320.78	13,846.26	115.30	3,292.15	1,431	2,635.72	1,007.40	
DANU_SRB	4,815.57	352.12	43.13	3,316.35	197	906.94	553.16	
DANU_SVK	2,383.64	652.35	22.48	356.45	976	376.61	454.73	
DANU_SVN	1,006.67	14.89	11.06	729.71	77	173.57	488.93	

DANU_UKR	1,111.43	645.94	21.33	79.47	157	207.33	435.59	
Total in Basin	53,821.60	18,959.84	437.48	19,096.38	7,886.24	7,441.66	671.22	24.27

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
DANU_ALB	0	0.00	11	82.72	0.39			0	4,652.35	0	0.00
DANU_AUT	81	0.10	7,618	94.48	0.39	0.00	100.00	5	49,053.82	22	272.86
DANU_BGR	48	0.06	3,351	70.45	-0.64	0.00	100.00	4	7,296.49	16	336.37
DANU_BIH	38	0.05	3,093	81.74	-0.11	0.34	99.66	2	4,655.60	6	158.55
DANU_CHE	2	0.00	23	12.58	0.66	100.00	0.00	0	80,477.43	0	0.00
DANU_CZE	22	0.03	2,729	125.72	0.53	0.00	100.00	2	18,861.43	9	414.55
DANU_DEU	56	0.07	9,868	175.97	-0.06	0.00	100.00	5	45,084.87	9	160.49
DANU_HRV	33	0.04	2,798	84.58	-0.18	4.24	95.76	1	13,529.88	2	60.47
DANU_HUN	93	0.12	9,500	102.02	-0.21	23.51	76.49	9	13,133.82	5	53.69
DANU_ITA	1	0.00	17	25.09	0.63			0	34,619.24	1	1,433.69
DANU_MDA	12	0.02	1,048	85.54		1.64	98.36	0	2,229.62	0	0.00
DANU_MFD	0	0.00	8	149.21				0	4,850.51	0	0.00
DANU_MNE	7	0.01	362	52.72	0.15	0.00	100.00	0	7,125.67	1	145.84
DANU_POL	0	0.00	37	84.91	0.06			0	13,431.95	0	0.00
DANU_ROM	230	0.29	21,164	92.01	-0.26	0.03	99.97	24	9,499.21	80	347.80
DANU_SRB	82	0.10	8,706	106.32	0.00	0.00	100.00	6	5,935.32	16	195.40
DANU_SVK	47	0.06	5,242	111.25	0.17	0.30	99.70	2	17,689.04	15	318.36
DANU_SVN	16	0.02	2,059	126.52	0.27	3.84	96.16	1	22,729.32	2	122.90
DANU_UKR	29	0.04	2,552	88.11	-0.64	0.00	100.00	2	3,900.47	0	0.00
Total in Basin	796	1.00	80,185	100.67	-0.18	3.12	96.79	63	18,477.98	184	231.01

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
DANU_ALB					5				2	3	2	5	1	2	1

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

DANU_AUT	1	2	2		2	2	5	4	5	1	3		5	1	3
DANU_BGR	2	5	3		4	2	5	4	4	2	3	1	4	1	3
DANU_BIH	1	1	2		5	1	5	4	4	1	3	3	5	2	3
DANU_CHE	1	1	2		1	4	4	5	2	3	2	1	1	1	2
DANU_CZE	2	3	2		2		5	4	3	2	1	1	3	1	3
DANU_DEU	1	2	2		1	1	5	5	4	1	1	1	1	1	3
DANU_HRV	1	1	2		5	2	4	4	4	1	3		5	1	2
DANU_HUN	2	5	3		3	2	4	4	3	1	1	2	5	1	3
DANU_ITA	1		2		1	3			3	2	2		1	2	1
DANU_MDA	2	5	3		4	1	4	3	3	1	1	4	2	1	3
DANU_MFD					5				2	5	3	5	1	2	1
DANU_MNE	1	1	2		5		5	4	3	2	5	3	4	1	3
DANU_POL					2				2	2	1	2	1	1	1
DANU_ROM	2	4	3		5	1	5	4	3	1	3	1	5	1	3
DANU_SRB	2	4	2		5	2	4	4	3	1	3	4	5	2	4
DANU_SVK	2	2	2		3	1	5	4	3	1	1	2	5	1	3
DANU_SVN	1	1	2		3		5	4	4	1	3	4	4	1	2
DANU_UKR	2	2	2		5	1	4	4	3	1	1	2	1	1	4
River Basin	2	3	2	4	3	2	5	4	5	1	2	3	5	2	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	**1.Environmental water stress**		**2.Human water stress**		**4.Nutrient pollution**		**16.Change in population density**		**11.Hydropolitical tension**
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
DANU_ALB									2
DANU_AUT	3	3	2	2			1	1	3
DANU_BGR	3	3	5	5			1	1	3
DANU_BIH	2	3	1	1			1	1	3
DANU_CHE	5	5	1	1			1	1	2

DANU_CZE	2	3	3	3			1	1	1
DANU_DEU	2	2	2	2			1	1	1
DANU_HRV	2	2	2	2			1	1	3
DANU_HUN	2	2	5	5			1	1	1
DANU_ITA	5	5							2
DANU_MDA	2	3	5	5			1	1	1
DANU_MFD									3
DANU_MNE	3	3	1	1					5
DANU_POL							1	1	1
DANU_ROM	3	3	5	5			1	1	3
DANU_SRB	2	3	5	5			3	5	3
DANU_SVK	2	3	3	3			1	1	1
DANU_SVN	2	3	1	2			1	1	3
DANU_UKR	3	3	3	3			1	1	1
River Basin	3	3	3	4	4	4	1	1	2

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1	2	5	1	4

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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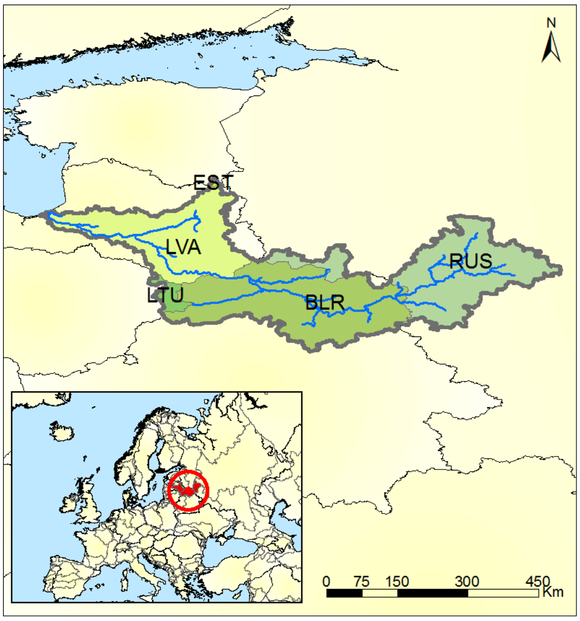
Daugava Basin



Geography

Total drainage area (km^2)	86,343
No. of countries in basin	5
BCUs in basin	Belarus (BLR), Estonia (EST), Latvia (LVA), Lithuania (LTU), Russian Federation (RUS)
Population in basin (people)	2,519,402
Country at mouth	Latvia
Average rainfall (mm/year)	719

Governance

No. of treaties and agreements[1]	5
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	4
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
DUGV_BLR		229.02				
DUGV_EST						
DUGV_LTU		300.88				
DUGV_LVA		328.60			137.00	0.54
DUGV_RUS		241.10			113.10	0.58
Total in Basin	22.48	260.37			250.10	1.12

Water Withdrawals

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
DUGV_BLR	702.30	16.67	12.25	448.04	95	130.61	654.33	
DUGV_EST								
DUGV_LTU	2,029.64	0.03	0.33	2,026.13	1	2.12	22,545.98	
DUGV_LVA	173.11	0.87	3.94	49.60	70	48.64	151.73	
DUGV_RUS	34.99	0.91	3.47	0.00	4	26.30	163.15	
Total in Basin	2,940.04	18.48	19.99	2,523.77	170.15	207.66	1,166.96	13.08

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
DUGV_BLR	33	0.39	1,073	32.11	-0.47	0.00	100.00	2	7,575.48	0	0.00
DUGV_EST	0	0.00	1	4.90				0	18,478.27	0	0.00
DUGV_LTU	2	0.02	90	48.30	-0.55	2.74	97.26	0	15,537.92	0	0.00
DUGV_LVA	23	0.27	1,141	48.75	-0.47	0.18	99.82	2	15,375.45	3	128.20
DUGV_RUS	28	0.32	214	7.79	-0.12			0	14,611.70	0	0.00
Total in Basin	86	1.00	2,519	29.18	-0.48	0.18	91.28	4	11,994.06	3	34.74

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
DUGV_BLR	1	1	2		1	2	2	2	2	2	2		1	1	3
DUGV_EST					2				2	4	2	2	1	2	1
DUGV_LTU	1	5	1		3	2	3	3	2	4	2	1	1	2	2
DUGV_LVA	1	2	2		3	1	3	2	2	4	2	2	5	1	2
DUGV_RUS	1	1	2		4	2	2	2	2	2	2	2	1	2	3
River Basin	1	2	2	3	2	2	2	3	2	3	2		3	2	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
DUGV_BLR	3	3	2	2			1	1	2
DUGV_EST									2
DUGV_LTU	1	2	5	5			1	1	2
DUGV_LVA	2	3	2	2			1	1	2
DUGV_RUS	3	3	1	1			1	1	2
River Basin	3	3	2	2	3	3	1	1	2

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

Indicators

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Dnieper Basin

Geography

Total drainage area (km^2)	511,383
No. of countries in basin	3
BCUs in basin	Belarus (BLR), Russian Federation (RUS), Ukraine (UKR)
Population in basin (people)	29,456,610
Country at mouth	Ukraine
Average rainfall (mm/year)	643

Governance

No. of treaties and agreements[1]	4
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	8
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
DNPR_BLR		146.24			60.50	0.18
DNPR_RUS		164.07			50.30	0.38
DNPR_UKR		114.32			5,588.90	38.21
Total in Basin	66.65	130.32			5,699.70	38.77

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
DNPR_BLR	1,571.87	121.37	54.19	223.11	533	640.12	257.45	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

DNPR_RUS	2,418.82	27.98	25.39	1,625.40	317	422.92	716.72	
DNPR_UKR	10,495.77	4,751.22	157.06	2,264.45	1,402	1,921.08	525.42	
Total in Basin	14,486.46	4,900.57	236.64	4,112.96	2,252.17	2,984.12	491.79	21.74

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
DNPR_BLR	119	0.23	6,106	51.44	-0.47	0.00	100.00	9	7,575.48	0	0.00
DNPR_RUS	100	0.19	3,375	33.85	-0.12	0.00	100.00	3	14,611.70	0	0.00
DNPR_UKR	293	0.57	19,976	68.18	-0.64	0.00	100.00	17	3,900.47	6	20.48
Total in Basin	511	1.00	29,457	57.60	-0.12	0.00	100.00	29	5,889.40	6	11.73

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	**Water Quantity**			**Water Quality**			**Ecosystems**			**Governance**			**Socioeconomics**		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
DNPR_BLR	2	1	2		1	3	3	3	3	2	2		5	1	3
DNPR_RUS	1	2	2		4	2	4	3	3	3	2	2	1	2	3
DNPR_UKR	2	3	3		5	2	4	3	3	2	2	2	4	1	3
River Basin	2	2	2	3	4	3	4	3	3	2	2		4	1	3

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Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	**1.Environmental water stress**		**2.Human water stress**		**4.Nutrient pollution**		**16.Change in population density**		**11.Hydropolitical tension**
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
DNPR_BLR	3	3	2	2			1	1	2
DNPR_RUS	3	3	2	2			1	1	2
DNPR_UKR	3	3	4	4			1	1	2
River Basin	3	3	3	3	3	3	1	1	2

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TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
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Dniester Basin

Geography

Total drainage area (km^2)	73,382
No. of countries in basin	3
BCUs in basin	Moldova, Republic Of (MDA), Poland (POL), Ukraine (UKR)
Population in basin (people)	7,253,798
Country at mouth	Ukraine
Average rainfall (mm/year)	667

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	2
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
DNSR_MDA		100.64			118.30	0.75
DNSR_POL						
DNSR_UKR		174.63			364.60	4.17
Total in Basin	11.58	157.87			482.90	4.93

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
DNSR_MDA	1,428.70	591.78	8.86	526.41	186	115.86	485.30	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

DNSR_POL								
DNSR_UKR	1,560.62	406.09	28.58	305.81	354	465.74	362.82	
Total in Basin	2,989.31	997.88	37.44	832.22	540.17	581.60	412.10	25.80

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
DNSR_MDA	19	0.26	2,944	152.10		0.00	100.00	4	2,229.62	1	51.66
DNSR_POL	0	0.00	9	36.87	0.06			0	13,431.95	0	0.00
DNSR_UKR	54	0.73	4,301	79.96	-0.64	0.00	100.00	3	3,900.47	1	18.59
Total in Basin	73	1.00	7,254	98.85	-0.14	0.00	99.88	7	3,233.59	2	27.25

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
DNSR_MDA	2	5	3		4	1	4	3	3	3	2	4	5	1	3
DNSR_POL					2				2	4	3	2	1	1	1
DNSR_UKR	2	2	2		5	1	4	3	3	2	2	2	1	1	2
River Basin	2	3	2	3	4	1	4	3	3	2	2	3	3	1	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
DNSR_MDA	3	3	5	5			1	1	2
DNSR_POL									3
DNSR_UKR	3	3	3	3			1	1	2
River Basin	3	3	4	4	3	4	1	1	2

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	2				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Don Basin

Geography

Total drainage area (km^2)	439,003
No. of countries in basin	2
BCUs in basin	Russian Federation (RUS), Ukraine (UKR)
Population in basin (people)	18,819,195
Country at mouth	Russian Federation
Average rainfall (mm/year)	551

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	8
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
DONX_RUS		105.00			3,306.40	23.13
DONX_UKR		90.50			168.60	0.65
Total in Basin	45.37	103.35			3,475.00	23.79

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
DONX_RUS	7,595.72	2,132.28	101.31	2,193.09	1,381	1,788.52	579.63	
DONX_UKR	2,609.22	735.75	28.43	880.95	451	512.73	456.57	

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Total in Basin	10,204.94	2,868.03	129.74	3,074.04	1,831.89	2,301.25	542.26	22.49

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
DONX_RUS	384	0.88	13,104	34.10	-0.12	0.00	100.00	13	14,611.70	2	5.20
DONX_UKR	55	0.12	5,715	104.43	-0.64	0.00	100.00	8	3,900.47	1	18.27
Total in Basin	439	1.00	18,819	42.87	0.09	0.00	100.00	21	11,359.00	3	6.83

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DONX_RUS	2	3	2		4	1	4	3	3	3	3	2	2	2	2
DONX_UKR	2	4	3		5		4	3	3	3	3	2	2	1	2
River Basin	2	3	2	4	5	1	4	3	3	3	3	2	2	2	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
DONX_RUS	4	4	3	3			1	1	3
DONX_UKR	3	3	4	5			1	1	3
River Basin	4	4	3	3	4	4	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	2				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Elancik Basin

Geography

Total drainage area (km²)	1,380
No. of countries in basin	2
BCUs in basin	Russian Federation (RUS), Ukraine (UKR)
Population in basin (people)	45,263
Country at mouth	Russian Federation
Average rainfall (mm/year)	

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km³/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km³/year)	Av. Groundwater Discharge (km³/year)	Lake and Reservoir Surface Area (km²)	Lake and Reservoir Volume (km³)
ELNK_RUS						
ELNK_UKR						
Total in Basin					0.00	0.00

Water Withdrawals

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
ELNK_RUS								
ELNK_UKR								

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Total in Basin								

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
ELNK_RUS	1	0.68	30	32.31	-0.12			0	14,611.70	0	0.00
ELNK_UKR	0	0.32	15	33.80	-0.64			0	3,900.47	0	0.00
Total in Basin	1	1.00	45	32.79	0.07	0.00	0.00	0	11,060.48	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ELNK_RUS					4				3	3	3	2	1	2	2
ELNK_UKR					5				3	3	3	2	1	1	1
River Basin				5	5				3	3	3	2	1	2	2

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Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
ELNK_RUS									3
ELNK_UKR									3
River Basin					5	5			3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin					

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Elbe Basin

Geography

Total drainage area (km²)	138,891
No. of countries in basin	4
BCUs in basin	Austria (AUT), Czech Republic (CZE), Germany (DEU), Poland (POL)
Population in basin (people)	21,860,257
Country at mouth	Germany
Average rainfall (mm/year)	718

Governance

No. of treaties and agreements[1]	8
No. of RBOs and Commissions[2]	2

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	0

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Water Resources

BCU	Annual Discharge (km³/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km³/year)	Av. Groundwater Discharge (km³/year)	Lake and Reservoir Surface Area (km²)	Lake and Reservoir Volume (km³)
ELBE_AUT						
ELBE_CZE		191.71				
ELBE_DEU		216.87			110.40	0.39
ELBE_POL						
Total in Basin	28.96	208.51			110.40	0.39

Water Withdrawals

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)

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ELBE_AUT								
ELBE_CZE	1,417.71	60.86	29.20	373.17	460	494.38	238.75	
ELBE_DEU	6,044.50	551.76	93.13	2,996.62	1,333	1,069.77	381.26	
ELBE_POL								
Total in Basin	7,462.21	612.62	122.32	3,369.78	1,793.33	1,564.15	341.36	25.77

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
ELBE_AUT	1	0.01	47	50.89	0.39	0.00	100.00	0	49,053.82	0	0.00
ELBE_CZE	50	0.36	5,938	119.06	0.53	0.00	100.00	2	18,861.43	21	421.07
ELBE_DEU	88	0.63	15,854	180.47	-0.06	0.00	100.00	14	45,084.87	21	239.05
ELBE_POL	0	0.00	21	86.98	0.06			0	13,431.95	0	0.00
Total in Basin	139	1.00	21,860	157.39	0.21	0.00	99.91	16	37,940.27	42	302.40

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
ELBE_AUT					2	3			2	4	3		1	1	1
ELBE_CZE	1	2	2		2	1	5	4	2	2	1	1	4	1	3
ELBE_DEU	2	4	2		1	1	5	3	2	2	1	1	3	1	3
ELBE_POL					2				2	2	1	2	1	1	1
River Basin	2	4	2	5	1	1	5	4	2	2	1	1	4	1	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	**1.Environmental water stress**		**2.Human water stress**		**4.Nutrient pollution**		**16.Change in population density**		**11.Hydropolitical tension**
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

ELBE_AUT									3
ELBE_CZE	2	2	2	2			1	1	1
ELBE_DEU	2	2	4	4			1	1	1
ELBE_POL									1
River Basin	2	2	4	4	5	5	1	1	1

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Har Us Nur Basin

Geography

Total drainage area (km^2)	186,997
No. of countries in basin	3
BCUs in basin	China (CHN), Mongolia (MNG), Russian Federation (RUS)
Population in basin (people)	258,794
Country at mouth	Mongolia
Average rainfall (mm/year)	153

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	18
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
HRUN_CHN						
HRUN_MNG		21.95			5,240.80	50.96
HRUN_RUS		17.48			68.40	0.62
Total in Basin	4.09	21.86			5,309.20	51.58

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
HRUN_CHN								

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[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

HRUN_MNG								
HRUN_RUS	0.78	0.00	0.26	0.00	0	0.52	189.84	
Total in Basin	324.26	222.13	14.83	76.97	0.99	9.34	1,252.98	7.93

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
HRUN_CHN	0	0.00	1	4.47	0.51			0	6,807.43	0	0.00
HRUN_MNG	183	0.98	254	1.60	1.58	89.99			2,286.00	0	0.00
HRUN_RUS	4	0.02	4	1.14	-0.12			0	14,611.70	0	0.00
Total in Basin	187	1.00	259	1.38	1.49	0.00	98.19	0	4,230.62	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
HRUN_CHN					5	5			3	2	1	2	1	2	1
HRUN_MNG	2	4	2		5	1	2	2	3	2	3	5	1	2	4
HRUN_RUS	1	5	1		4	1	3	1	3	3	3	2	1	2	2
River Basin	2	4	2	2	5	1	2	2	3	2	3	5	1	2	4

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
HRUN_CHN									1
HRUN_MNG	3	3	5	5			2	3	3
HRUN_RUS	2	2	5	4			1	1	3
River Basin	3	3	4	5	2	2	2	2	3

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	5				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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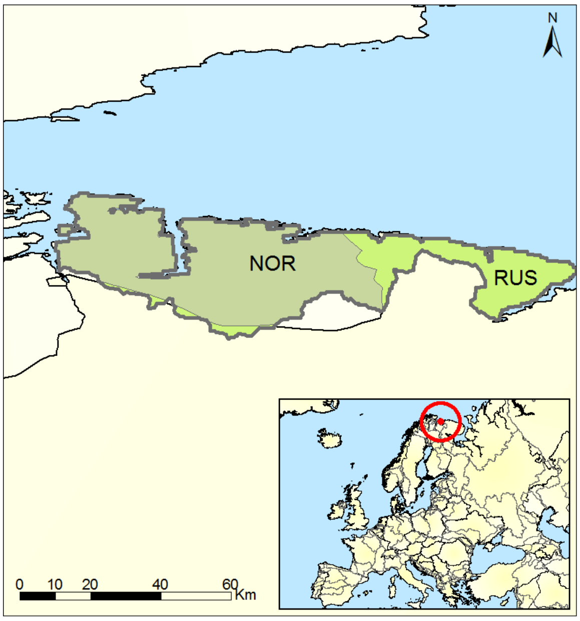
Jacobs Basin



Geography

Total drainage area (km²)	944
No. of countries in basin	2
BCUs in basin	Norway (NOR), Russian Federation (RUS)
Population in basin (people)	1,972
Country at mouth	Norway
Average rainfall (mm/year)	653

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
JCBS_NOR		330.97				
JCBS_RUS		154.70				
Total in Basin	0.23	242.84			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
JCBS_NOR	0.30	0.00	0.01	0.00	0	0.28	196.27	
JCBS_RUS	0.12	0.00	0.00	0.00	0	0.12	252.24	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	0.41	0.00	0.02	0.00	0.00	0.40	209.43	0.18

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
JCBS_ NOR	1	0.73	2	2.18	1.09			0	100,818.50	0	0.00
JCBS_ RUS	0	0.27	0	1.85	-0.12			0	14,611.70	0	0.00
Total in Basin	1	1.00	2	2.09	1.05	0.00	0.00	0	80,545.88	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
JCBS_NOR	1	1	1		2		3		3	4	3	1	1	1	1
JCBS_RUS	1	1	1		4		3		3	3	3	2	1	2	1
River Basin	1	1	1	2	2		3		3	4	3	2	1	1	1

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
JCBS_NOR	4	4	1	1					3
JCBS_RUS	4	4	1	1					3
River Basin	4	4	1	1	2	2			3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

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Jenisej/Yenisey Basin

Geography

Total drainage area (km^2)	2,504,604
No. of countries in basin	2
BCUs in basin	Mongolia (MNG), Russian Federation (RUS)
Population in basin (people)	7,802,049
Country at mouth	Russian Federation
Average rainfall (mm/year)	466

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	33
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
YNSY_MNG		62.95			2,800.50	379.49
YNSY_RUS		279.54			45,754.24	24,182.50
Total in Basin	630.67	251.81			48,554.74	24,561.99

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
YNSY_MNG								
YNSY_RUS	2,335.08	77.13	22.79	956.56	477	801.91	388.16	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	2,985.64	314.57	57.04	1,262.68	489.72	861.64	382.67	0.47

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
YNSY_MNG	318	0.13	1,786	5.32	1.58	28.92			2,286.00	0	0.00
YNSY_RUS	2,187	0.87	6,016	2.75	-0.12	0.00	100.00	9	14,611.70	7	3.20
Total in Basin	2,505	1.00	7,802	3.12	0.52	0.00	100.00	10	12,194.97	7	2.79

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
YNSY_MNG	2	2	2		5	2	3	1	3	4	3	5	1	2	2
YNSY_RUS	2	1	2		4	1	3	2	4	2	3	2	1	2	3
River Basin	2	1	2	1	5	1	3	2	3	3	3	3	1	2	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
YNSY_MNG	3	4	3	3			2	3	3
YNSY_RUS	4	5	1	1			1	1	3
River Basin	4	5	1	1	1	1	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	5				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

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Kemi Basin

Geography

Total drainage area (km^2)	53,911
No. of countries in basin	3
BCUs in basin	Finland (FIN), Norway (NOR), Russian Federation (RUS)
Population in basin (people)	104,757
Country at mouth	Finland
Average rainfall (mm/year)	599

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	4
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
KEMI_FIN		332.96			851.10	17.32
KEMI_NOR						
KEMI_RUS		387.60				
Total in Basin	18.13	336.30			851.10	17.32

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
KEMI_FIN	29.14	0.15	0.65	5.48	13	9.46	303.50	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

KEMI_NOR								
KEMI_RUS	1.29	0.00	0.03	0.00	0	1.25	147.47	
Total in Basin	30.43	0.15	0.68	5.48	13.41	10.71	290.48	0.17

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
KEMI_FIN	51	0.94	96	1.89	0.45	0.00	100.00	0	47,218.77	9	177.34
KEMI_NOR	0	0.00	0	0.27				0	100,818.50	0	0.00
KEMI_RUS	3	0.06	9	2.78	-0.12			0	14,611.70	0	0.00
Total in Basin	54	1.00	105	1.94	0.45	0.00	91.66	0	44,504.24	9	166.94

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
KEMI_FIN	2	1	1		1	1	4	3	3	3	2	1	1	1	1
KEMI_NOR					2				3	4	2	1	1	1	1
KEMI_RUS	1	1	1		4		3	1	3	2	3	2	1	2	1
River Basin	2	1	1	2	2	1	4	3	3	3	2	1	1	1	1

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
KEMI_FIN	4	5	1	1			1	1	2
KEMI_NOR									2
KEMI_RUS	5	5	1	1			1	1	3
River Basin	4	5	1	1	2	2	1	1	2

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	3				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Kogilnik Basin

Geography

Total drainage area (km^2)	3,952
No. of countries in basin	2
BCUs in basin	Moldova, Republic Of (MDA), Ukraine (UKR)
Population in basin (people)	178,942
Country at mouth	Ukraine
Average rainfall (mm/year)	546

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
KGNK_MDA		154.53				
KGNK_UKR		107.70				
Total in Basin	0.52	131.01			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
KGNK_MDA	77.66	1.80	0.94	0.00	53	21.43	691.28	
KGNK_UKR	6.42	0.00	0.69	0.00	1	5.05	96.35	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	84.08	1.80	1.62	0.00	54.18	26.47	469.86	16.24

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
KGNK_MDA	2	0.39	112	72.62		0.00	100.00	0	2,229.62	0	0.00
KGNK_UKR	2	0.61	67	27.69	-0.64			0	3,900.47	0	0.00
Total in Basin	4	1.00	179	45.28	-0.09	0.00	62.78	0	2,851.47	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
KGNK_MDA	1	5	2		4		4	3	3	3	3	4	1	1	2
KGNK_UKR	1	4	1		5		2	3	3	3	3	2	1	1	3
River Basin	1	4	2	3	4		3	3	3	3	3	3	1	1	3

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Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
KGNK_MDA	2	3	5	5			1	1	3
KGNK_UKR	2	2	4	4			1	1	3
River Basin	2	3	4	5	3	3	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

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Kura-Araks Basin

Geography

Total drainage area (km²)	190,033
No. of countries in basin	6
BCUs in basin	Armenia (ARM), Azerbaijan (AZE), Georgia (GEO), Iran (Islamic Republic of) (IRN), Russian Federation (RUS), Turkey (TUR)
Population in basin (people)	14,462,042
Country at mouth	Azerbaijan
Average rainfall (mm/year)	519

Governance

No. of treaties and agreements[1]	5
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	6
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km³/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km³/year)	Av. Groundwater Discharge (km³/year)	Lake and Reservoir Surface Area (km²)	Lake and Reservoir Volume (km³)
KURA_ARM		128.01			1,249.90	11.25
KURA_AZE		108.83			604.70	8.26
KURA_GEO		254.40				
KURA_IRN		92.76			106.80	0.70
KURA_RUS						
KURA_TUR		95.16			121.20	2.55
Total in Basin	25.28	133.02			2,082.60	22.76

Water Withdrawals

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
KURA_ARM	2,634.36	1,814.64	10.29	448.32	108	253.06	696.90	
KURA_AZE	12,076.35	9,493.69	35.09	1,817.57	103	627.13	2,733.08	
KURA_GEO	1,762.26	1,077.83	17.16	162.42	175	329.97	622.44	
KURA_IRN	8,470.13	7,015.19	22.92	860.06	108	464.24	3,531.53	
KURA_RUS								
KURA_TUR	1,335.29	1,242.64	7.16	3.84	11	71.15	1,297.94	
Total in Basin	26,278.39	20,643.98	92.63	3,292.21	504.03	1,745.54	1,817.06	103.95

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
KURA_ARM	30	0.16	3,780	127.61	0.17	0.36	99.64	2	3,504.77	4	135.03
KURA_AZE	60	0.31	4,419	73.93	1.35	0.00	100.00	1	7,811.79	2	33.46
KURA_GEO	35	0.18	2,831	82.03	-0.57	0.41	99.59	2	3,602.17	4	115.89
KURA_IRN	37	0.20	2,398	64.63	1.18	0.00	100.00	3	4,763.30	2	53.90
KURA_RUS	0	0.00	5	30.52	-0.12			0	14,611.70	0	0.00
KURA_TUR	29	0.15	1,029	35.65	1.31	0.00	100.00	0	10,945.92	1	34.65
Total in Basin	190	1.00	14,462	76.10	0.71	0.17	99.79	8	5,581.58	13	68.41

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
KURA_ARM	4	4	4		4	1	5	2	3	3	2	5	5	1	2
KURA_AZE	4	5	5		5	2	4	2	3	3	2	3	5	2	2
KURA_GEO	2	3	3		5	1	5	1	3	3	3	4	5	2	3
KURA_IRN	5	5	5		5	1	4	2	3	2	2	2	1	3	3
KURA_RUS					4	3			3	2	3	2	1	2	1
KURA_TUR	5	3	5		3	1	5	2	3	5	3		1	3	5
River Basin	4	5	5	3	5	1	5	2	3	3	2	4	4	3	3

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Very low	Low	Medium	High	Very high

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Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
KURA_ARM	5	5	5	5			1	1	3
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KURA_RUS									4
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Lake Ubsa-Nur Basin

Geography

Total drainage area (km^2)	70,328
No. of countries in basin	2
BCUs in basin	Mongolia (MNG), Russian Federation (RUS)
Population in basin (people)	89,240
Country at mouth	Mongolia
Average rainfall (mm/year)	199

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	2
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
LKUN_MNG		22.57			3,421.47	20.59
LKUN_RUS		30.72			68.93	0.59
Total in Basin	1.75	24.94			3,490.40	21.19

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
LKUN_MNG								
LKUN_RUS	19.00	15.80	0.64	0.00	0	2.55	915.31	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	144.18	135.92	3.23	0.00	0.23	4.79	1,615.63	8.22

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
LKUN_MNG	50	0.71	68	2.43	1.58	80.04			2,286.00	0	0.00
LKUN_RUS	20	0.29	21	1.03	-0.12			0	14,611.70	0	0.00
Total in Basin	70	1.00	89	1.27	1.21	0.00	76.74	0	6,511.99	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
LKUN_MNG	2	3	2		5	2	1	1	3	5	3	5	1	2	4
LKUN_RUS	2	5	2		4	2	1	1	4	3	3	2	1	2	3
River Basin	2	4	2	2	5	2	1	1	3	4	3	4	1	2	4

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
LKUN_MNG	3	4	3	3			2	3	3
LKUN_RUS	3	3	3	3			1	1	3
River Basin	3	4	3	3	2	2	1	2	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	5				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Lava/Pregel Basin

Geography

Total drainage area (km^2)	14,466
No. of countries in basin	3
BCUs in basin	Lithuania (LTU), Poland (POL), Russian Federation (RUS)
Population in basin (people)	1,068,308
Country at mouth	Russian Federation
Average rainfall (mm/year)	727

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
LAVA_LTU						
LAVA_POL		291.25			102.70	1.09
LAVA_RUS		406.87				
Total in Basin	4.82	332.88			102.70	1.09

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
LAVA_LTU								

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LAVA_POL	66.50	9.49	3.96	1.14	6	46.24	121.30	
LAVA_RUS	188.32	2.25	13.91	151.51	8	12.89	363.74	
Total in Basin	254.82	11.75	17.87	152.65	13.42	59.13	238.52	5.29

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
LAVA_LTU	0	0.00	2	39.30				0	15,537.92	0	0.00
LAVA_POL	8	0.55	548	69.53	0.06	0.00	100.00	1	13,431.95	0	0.00
LAVA_RUS	7	0.45	518	79.39	-0.12	0.00	100.00	1	14,611.70	0	0.00
Total in Basin	14	1.00	1,068	73.85	0.10	0.00	99.78	2	14,008.31	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
LAVA_LTU					3				2	2	3	1	1	2	1
LAVA_POL	1	1	2		2		2	3	2	2	3	2	1	1	2
LAVA_RUS	1	1	2		4	2	2	3	2	2	3	2	1	2	3
River Basin	1	1	2	4	3	1	2	3	2	2	3	2	1	2	2

Indicators

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Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
LAVA_LTU									3
LAVA_POL	2	2	1	1			1	1	3
LAVA_RUS	2	2	1	1			1	1	3
River Basin	2	2	1	1	4	5	1	1	3

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1				

Indicators

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Maritsa Basin

Geography

Total drainage area (km^2)	52,590
No. of countries in basin	3
BCUs in basin	Bulgaria (BGR), Greece (GRC), Turkey (TUR)
Population in basin (people)	3,476,248
Country at mouth	Greece, Turkey
Average rainfall (mm/year)	629

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
MRSA_BGR		194.24				
MRSA_GRC		307.47				
MRSA_TUR		275.60				
Total in Basin	11.97	227.61			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
MRSA_BGR	4,070.42	1,794.50	9.40	1,650.39	332	284.56	1,906.20	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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MRSA_GRC	404.85	389.27	1.26	0.00	0	14.32	4,888.30	
MRSA_TUR	1,928.52	1,162.59	10.26	214.94	169	372.12	1,532.92	
Total in Basin	6,403.79	3,346.36	20.92	1,865.33	500.19	671.00	1,842.16	53.50

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
MRSA_BGR	35	0.67	2,135	60.94	-0.64	0.00	100.00	3	7,296.49	19	542.22
MRSA_GRC	3	0.06	83	26.96	0.31	66.75	33.25	0	21,910.22	0	0.00
MRSA_TUR	14	0.28	1,258	86.90	1.31	0.00	100.00	1	10,945.92	7	483.52
Total in Basin	53	1.00	3,476	66.10	0.10	1.59	98.41	4	8,965.40	26	494.39

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
MRSA_BGR	2	5	3		4	1	5	3	3	1	4	1	4	1	3
MRSA_GRC	2	4	3		1	1	5	4	3	4	5	3	1	1	3
MRSA_TUR	3	4	3		3	1	5	3	3	2	4		1	2	2
River Basin	2	4	3	4	4	1	5	3	3	2	4		3	2	2

Indicators

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Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
MRSA_BGR	3	4	5	5			1	1	4
MRSA_GRC	3	4	5	5			1	1	5
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River Basin	3	4	5	5	4	4	1	1	4

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TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1				

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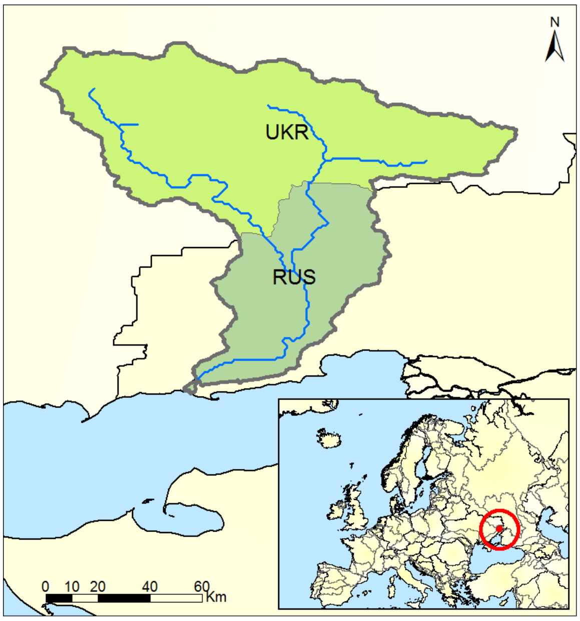
Mius Basin



Geography

Total drainage area (km^2)	7,088
No. of countries in basin	2
BCUs in basin	Russian Federation (RUS), Ukraine (UKR)
Population in basin (people)	1,189,275
Country at mouth	Russian Federation
Average rainfall (mm/year)	607

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	1

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MIUS_RUS		121.39			57.30	0.06
MIUS_UKR		209.62				
Total in Basin	1.22	171.50			57.30	0.06

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
MIUS_RUS	137.40	0.00	1.48	0.00	65	70.78	845.82	
MIUS_UKR	1,408.36	181.38	4.88	931.09	144	147.17	1,371.56	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	1,545.76	181.38	6.36	931.09	208.99	217.95	1,299.75	127.17

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
MIUS_RUS	2	0.32	162	72.29	-0.12			0	14,611.70	0	0.00
MIUS_UKR	5	0.68	1,027	212.13	-0.64	0.00	100.00	1	3,900.47	0	0.00
Total in Basin	7	1.00	1,189	167.79	-0.17	0.00	86.34	1	5,363.56	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
MIUS_RUS	2	2	1		4	1	4	3	3	3	3	2	1	2	3
MIUS_UKR	2	4	3		5		3	3	3	3	3	2	1	1	2
River Basin	2	4	2	5	5	1	3	3	2	3	3	2	1	2	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
MIUS_RUS	3	3	2	2					3
MIUS_UKR	4	3	5	5			1	1	3
River Basin	3	3	4	5	5	5	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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TWAP RB assessment includes 286 transboundary river basins. Information on this layer and delineation methodology can be retrieved by downloading metadata sheet for the Basins layer from TWAP Rivers Data Portal at http://twap-rivers.org/indicators/ or by direct download from http://twap-rivers.org/assets/Basin%20and%20BCU%20Creation%20Documentation.pdf

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Narva Basin

Geography

Total drainage area (km²)	56,519
No. of countries in basin	4
BCUs in basin	Belarus (BLR), Estonia (EST), Latvia (LVA), Russian Federation (RUS)
Population in basin (people)	897,899
Country at mouth	Estonia, Russian Federation
Average rainfall (mm/year)	714

Governance

No. of treaties and agreements[1]	4
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	3
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
NRVA_BLR						
NRVA_EST		257.04			1,908.72	12.12
NRVA_LVA		226.35				
NRVA_RUS		272.20			2,031.58	13.80
Total in Basin	14.98	264.99			3,940.30	25.92

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)

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NRVA_BLR								
NRVA_EST	1,225.23	1.31	2.88	1,184.09	15	22.17	3,277.70	
NRVA_LVA	4.60	0.05	0.25	0.00	1	3.42	98.87	
NRVA_RUS	125.88	2.54	5.82	4.21	40	73.03	263.77	
Total in Basin	1,355.71	3.90	8.95	1,188.30	55.95	98.61	1,509.87	9.05

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
NRVA_BLR	0	0.00	0	13.38	-0.47			0	7,575.48	0	0.00
NRVA_EST	17	0.31	374	21.38	-0.07	1.16	98.84	1	18,478.27	0	0.00
NRVA_LVA	3	0.06	47	13.70	-0.47	15.76	84.24	0	15,375.45	0	0.00
NRVA_RUS	36	0.63	477	13.40	-0.12	0.00	100.00	1	14,611.70	0	0.00
Total in Basin	57	1.00	898	15.89	0.05	1.30	98.66	2	16,258.16	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
NRVA_BLR					1				2	3	3		1	1	1
NRVA_EST	1	2	2		2	1	2	2	3	2	2	2	4	2	2
NRVA_LVA	1	1	1		3	1	2	2	2	2	3	2	1	1	2
NRVA_RUS	1	1	2		4	2	1	1	3	2	2	2	1	2	3
River Basin	1	1	2	3	3	2	1	2	2	2	2	2	2	2	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

NRVA_BLR									3
NRVA_EST	3	3	2	2			1	1	2
NRVA_LVA	3	3	1	1			1	1	3
NRVA_RUS	2	2	1	1			1	1	2
River Basin	2	3	1	1	3	3	1	1	2

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	4				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Neman Basin

Geography

Total drainage area (km^2)	92,929
No. of countries in basin	5
BCUs in basin	Belarus (BLR), Latvia (LVA), Lithuania (LTU), Poland (POL), Russian Federation (RUS)
Population in basin (people)	4,788,665
Country at mouth	Latvia, Russian Federation
Average rainfall (mm/year)	705

Governance

No. of treaties and agreements[1]	7
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	3
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
NMAN_BLR		191.43			173.40	1.28
NMAN_LTU		248.46			56.90	1.42
NMAN_LVA						
NMAN_POL		167.87				
NMAN_RUS		318.01				
Total in Basin	20.74	223.23			230.30	2.70

Water Withdrawals

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[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
NMAN_BLR	548.73	35.96	39.56	1.98	217	254.59	274.57	
NMAN_LTU	316.14	5.63	17.83	150.94	52	89.36	122.46	
NMAN_LVA								
NMAN_POL	6.10	0.78	0.46	0.00	0	4.87	50.01	
NMAN_RUS	9.01	1.51	4.40	0.00	1	2.57	105.84	
Total in Basin	879.98	43.87	62.24	152.92	269.56	351.39	183.76	4.24

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
NMAN_BLR	45	0.48	1,999	44.57	-0.47	0.00	100.00	3	7,575.48	1	22.30
NMAN_LTU	44	0.47	2,582	59.03	-0.55	0.97	99.03	3	15,537.92	1	22.87
NMAN_LVA	0	0.00	1	18.65	-0.47	100.00	0.00	0	15,375.45	0	0.00
NMAN_POL	3	0.03	122	48.34	0.06	0.00	100.00	0	13,431.95	0	0.00
NMAN_RUS	2	0.02	85	48.44	-0.12	0.00	100.00	0	14,611.70	0	0.00
Total in Basin	93	1.00	4,789	51.53	-0.56	0.55	99.45	6	12,144.65	2	21.52

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
NMAN_BLR	1	1	2		1	1	3	3	2	2	2		2	1	2
NMAN_LTU	1	1	2		3	2	4	3	2	2	2	1	5	2	3
NMAN_LVA					3	3			2	2	2	2	1	1	1
NMAN_POL	1	1	2		2	2	4	3	2	2	3	2	1	1	2
NMAN_RUS	1	1	2		4	2	3	3	2	2	2	2	1	2	2
River Basin	1	1	2	4	2	1	4	3	2	2	2		4	2	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

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Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
NMAN_BLR	2	3	1	1			1	1	2
NMAN_LTU	2	2	2	2			1	1	2
NMAN_LVA									2
NMAN_POL	2	2	1	1			1	1	3
NMAN_RUS	2	2	1	1			1	1	2
River Basin	2	2	1	1	4	4	1	1	2

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance individual entities, not dependent from countries, with corresponding coding. Same approach has been taken by TWAP RB, reporting on disputed territories, as well as presentation of Basin Country Units.

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Nestos Basin

Geography

Total drainage area (km^2)	5,888
No. of countries in basin	2
BCUs in basin	Bulgaria (BGR), Greece (GRC)
Population in basin (people)	179,201
Country at mouth	Greece
Average rainfall (mm/year)	592

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
NSTO_BGR		305.56				
NSTO_GRC		295.09				
Total in Basin	1.76	298.56			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
NSTO_BGR	45.78	21.28	0.45	0.00	12	11.88	325.19	
NSTO_GRC	236.73	210.44	1.16	0.24	1	23.53	6,160.73	

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[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	282.51	231.73	1.60	0.24	13.53	35.41	1,576.48	16.07

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
NSTO_BGR	3	0.58	141	41.36	-0.64			0	7,296.49	1	293.80
NSTO_GRC	2	0.42	38	15.47	0.31	100.00	0.00	0	21,910.22	2	804.95
Total in Basin	6	1.00	179	30.43	-0.56	21.44	0.00	0	10,430.06	3	509.49

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
NSTO_BGR	2	2	2		4		5	1	3	3	3	1	1	1	2
NSTO_GRC	3	3	3		1	3	5	2	3	3	3	3	1	1	2
River Basin	2	3	3	4	3	1	5	2	2	3	3	2	1	2	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
NSTO_BGR	3	4	2	3			1	1	3
NSTO_GRC	4	4	4	4			1	1	3
River Basin	3	4	3	3	4	4	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Ob Basin

Geography

Total drainage area (km²)	3,042,475
No. of countries in basin	4
BCUs in basin	China (CHN), Kazakhstan (KAZ), Mongolia (MNG), Russian Federation (RUS)
Population in basin (people)	30,697,016
Country at mouth	Russian Federation
Average rainfall (mm/year)	515

Governance

No. of treaties and agreements[1]	4
No. of RBOs and Commissions[2]	2

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	88
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
OBXX_CHN		172.49				
OBXX_KAZ		52.33			10,030.00	58.49
OBXX_MNG						
OBXX_RUS		206.41			9,131.93	87.33
Total in Basin	499.00	164.01			19,198.20	146.10

Water Withdrawals

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
OBXX_CHN	2,857.68	2,837.79	7.05	0.00	0	12.85	7,364.87	
OBXX_KAZ	8,839.59	4,759.81	54.16	2,606.66	797	621.91	1,302.12	
OBXX_MNG								
OBXX_RUS	10,406.17	546.53	108.51	5,009.08	1,933	2,808.76	442.50	
Total in Basin	22,103.44	8,144.13	169.72	7,615.74	2,730.34	3,443.51	720.05	4.43

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
OBXX_CHN	50	0.02	388	7.75	0.51	0.00	100.00	0	6,807.43	0	0.00
OBXX_KAZ	791	0.26	6,789	8.59	1.10	0.00	100.00	11	13,171.81	5	6.32
OBXX_MNG	1	0.00	3	2.01	1.58	63.25			2,286.00	0	0.00
OBXX_RUS	2,200	0.72	23,517	10.69	-0.12	0.00	100.00	25	14,611.70	1	0.45
Total in Basin	3,042	1.00	30,697	10.09	0.50	0.00	99.99	36	14,193.46	6	1.97

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
OBXX_CHN	2	5	3		5	2	4	3	3	2	3	2	1	2	3
OBXX_KAZ	2	2	3		4	3	3	3	3	2	4	3	3	2	2
OBXX_MNG					5	2			3	2	3	5	1	2	1
OBXX_RUS	2	1	2		4	2	3	3	4	3	4	2	2	2	3
River Basin	2	1	2	3	4	2	3	3	3	3	4	2	2	3	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
OBXX_CHN	4	5	5	5			1	1	3
OBXX_KAZ	5	5	2	2			1	2	4
OBXX_MNG									3
OBXX_RUS	3	4	1	1			1	1	4
River Basin	4	5	1	1	3	2	1	1	4

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	2				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Oder/Odra Basin

Geography

Total drainage area (km^2)	119,245
No. of countries in basin	4
BCUs in basin	Czech Republic (CZE), Germany (DEU), Poland (POL), Slovakia (SVK)
Population in basin (people)	15,718,061
Country at mouth	Poland
Average rainfall (mm/year)	674

Governance

No. of treaties and agreements[1]	7
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
ODER_CZE		304.22				
ODER_DEU		185.45				
ODER_POL		168.69			53.90	0.40
ODER_SVK						
Total in Basin	21.00	176.11			53.90	0.40

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)

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[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

ODER_CZE	226.14	0.31	5.88	15.56	107	97.77	150.38	
ODER_DEU	137.32	10.70	3.55	34.17	43	46.32	228.32	
ODER_POL	4,356.65	103.59	69.73	2,637.22	548	997.95	320.04	
ODER_SVK								
Total in Basin	4,720.11	114.60	79.16	2,686.96	697.35	1,142.04	300.30	22.48

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
ODER_CZE	7	0.06	1,504	207.20	0.53	0.00	100.00	2	18,861.43	5	688.93
ODER_DEU	6	0.05	601	105.15	-0.06	0.00	100.00	0	45,084.87	0	0.00
ODER_POL	106	0.89	13,613	128.10	0.06	0.00	100.00	15	13,431.95	10	94.10
ODER_SVK	0	0.00	0	0.00	0.17			0	17,689.04	0	0.00
Total in Basin	119	1.00	15,718	131.81	0.01	0.00	100.00	17	15,162.56	15	125.79

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
ODER_CZE	1	1	2		2	1	5	4	2	2	1	1	1	1	2
ODER_DEU	1	4	2		1		4	3	2	2	1	1	1	1	3
ODER_POL	2	4	2		2	1	4	3	2	2	1	2	3	1	2
ODER_SVK					3					3	1	2	1	1	
River Basin	2	4	2	4	2	1	4	4	2	2	1	2	3	2	2

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Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

ODER_CZE	2	2	2	2			1	1	1
ODER_DEU	2	2	5	4			1	1	1
ODER_POL	2	2	4	4			1	1	1
ODER_SVK							1	1	1
River Basin	2	2	4	4	5	5	1	1	1

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1				

Indicators

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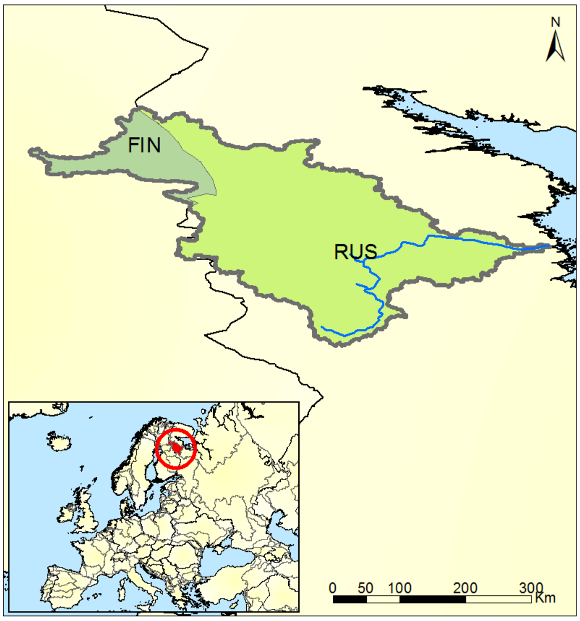
Olanga Basin



Geography

Total drainage area (km^2)	41,766
No. of countries in basin	2
BCUs in basin	Finland (FIN), Russian Federation (RUS)
Population in basin (people)	49,787
Country at mouth	Russian Federation
Average rainfall (mm/year)	606

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	13
Large Marine Ecosystems	0

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All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
OLNG_FIN		414.74			383.70	4.16
OLNG_RUS		289.30			2,504.10	35.47
Total in Basin	12.65	302.91			2,887.80	39.63

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
OLNG_FIN	1.10	0.02	0.13	0.02	0	0.92	101.01	
OLNG_RUS	7.41	0.00	0.20	0.00	1	6.67	190.33	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	8.50	0.03	0.33	0.02	0.54	7.58	170.81	0.07

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
OLNG_FIN	6	0.14	11	1.88	0.45	0.00	100.00	0	47,218.77	0	0.00
OLNG_RUS	36	0.86	39	1.08	-0.12	0.00	100.00	0	14,611.70	0	0.00
Total in Basin	42	1.00	50	1.19	0.28	0.00	100.00	0	21,737.24	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
OLNG_FIN	1	1	1		1		2	2	3	3	2	1	1	1	1
OLNG_RUS	1	1	1		4	1	2	1	3	2	2	2	1	2	1
River Basin	1	1	1	2	4	1	2	2	2	2	2	2	1	2	1

Indicators

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Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
OLNG_FIN	3	3	1	1			1	1	2
OLNG_RUS	2	3	1	1			1	1	2
River Basin	2	4	1	1	2	2	1	1	2

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	5				

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Oral/Ural Basin

Geography

Total drainage area (km²)	211,721
No. of countries in basin	2
BCUs in basin	Kazakhstan (KAZ), Russian Federation (RUS)
Population in basin (people)	3,613,089
Country at mouth	Kazakhstan
Average rainfall (mm/year)	380

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	7
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
ORAL_KAZ		39.27			257.40	2.62
ORAL_RUS		58.92			351.90	3.96
Total in Basin	10.38	49.03			609.30	6.58

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
ORAL_KAZ	1,674.49	764.54	5.92	670.54	133	100.40	1,661.05	
ORAL_RUS	2,193.42	185.97	21.75	1,424.59	225	336.09	842.01	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	3,867.92	950.51	27.67	2,095.13	358.13	436.49	1,070.53	37.26

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
ORAL_KAZ	90	0.43	1,008	11.15	1.10	0.00	100.00	3	13,171.81	0	0.00
ORAL_RUS	121	0.57	2,605	21.47	-0.12	0.00	100.00	4	14,611.70	1	8.24
Total in Basin	212	1.00	3,613	17.07	0.57	0.00	100.00	7	14,209.95	1	4.72

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
ORAL_KAZ	2	3	3		4	2	3	2	3	3	3	3	1	2	3
ORAL_RUS	2	3	2		4	1	3	2	3	3	3	2	1	2	2
River Basin	2	3	2	3	4	1	3	2	3	3	3	3	1	3	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
ORAL_KAZ	5	5	3	3			1	2	3
ORAL_RUS	5	5	3	3			1	1	3
River Basin	5	5	3	3	3	3	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	3				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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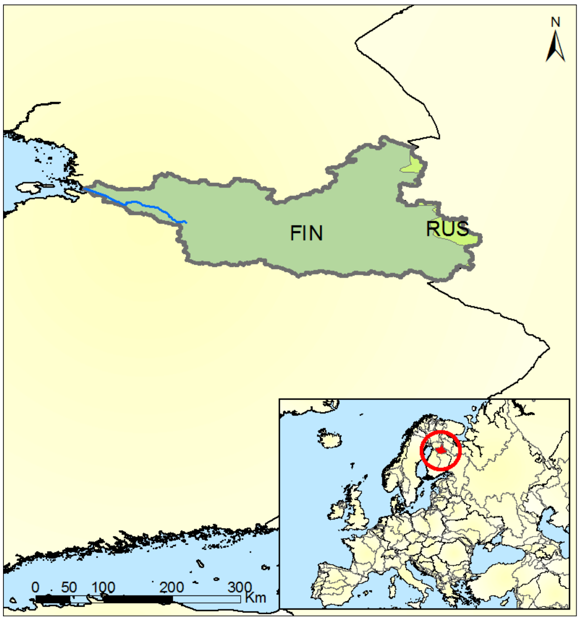
Oulu Basin



Geography

Total drainage area (km^2)	25,972
No. of countries in basin	2
BCUs in basin	Finland (FIN), Russian Federation (RUS)
Population in basin (people)	172,018
Country at mouth	Finland
Average rainfall (mm/year)	658

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	8
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
OULU_FIN		348.56			1,406.10	37.71
OULU_RUS		336.06			105.70	0.85
Total in Basin	9.04	348.11			1,511.80	38.55

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
OULU_FIN	87.07	4.57	2.12	13.17	46	20.74	507.83	
OULU_RUS	0.15	0.00	0.01	0.00	0	0.13	258.25	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	87.22	4.57	2.13	13.17	46.47	20.88	507.01	0.96

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
OULU_FIN	25	0.95	171	6.95	0.45	34.27	65.73	0	47,218.77	1	40.51
OULU_RUS	1	0.05	1	0.44	-0.12			0	14,611.70	0	0.00
Total in Basin	26	1.00	172	6.62	0.47	34.16	65.52	0	47,112.63	1	38.50

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
OULU_FIN	2	1	2		1		3	3	3	4	2	1	1	1	1
OULU_RUS	1	1	1		4		2	2	3	3	2	2	1	2	1
River Basin	2	1	2	3	1		3	3	3	4	2	1	1	1	1

Indicators

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Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
OULU_FIN	3	4	1	1			1	1	2
OULU_RUS	3	5	1	1			1	1	2
River Basin	3	4	1	1	3	3	1	1	2

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	5				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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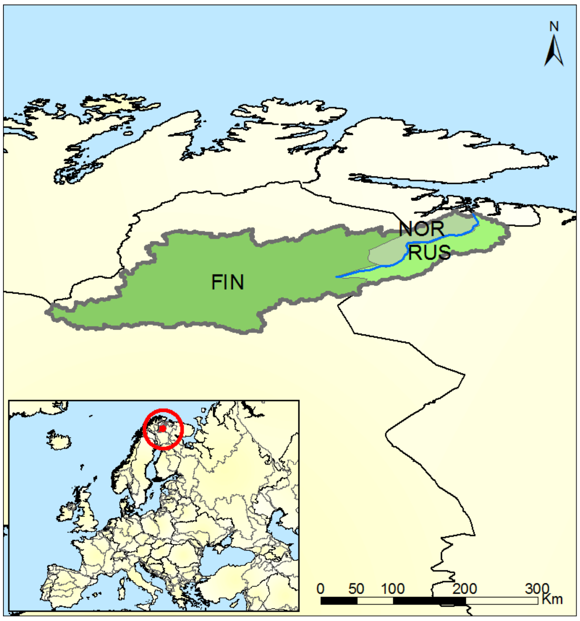
Pasvik Basin



Geography

Total drainage area (km^2)	17,961
No. of countries in basin	2
BCUs in basin	Finland (FIN), Norway (NOR), Russian Federation (RUS)
Population in basin (people)	12,893
Country at mouth	Norway, Russian Federation
Average rainfall (mm/year)	499

Governance

No. of treaties and agreements[1]	10
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	2
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
PSVK_FIN		392.19			1,184.60	16.58
PSVK_NOR		294.53			43.32	0.25
PSVK_RUS		282.77			22.78	0.13
Total in Basin	6.57	365.65			1,250.70	16.97

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
PSVK_FIN	0.59	0.00	0.05	0.02	0	0.53	116.05	

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[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

PSVK_NOR	1.29	0.00	0.07	0.00	0	1.22	389.09	
PSVK_RUS	0.55	0.00	0.02	0.00	0	0.53	121.49	
Total in Basin	2.43	0.00	0.13	0.02	0.00	2.28	188.16	0.04

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
PSVK_FIN	14	0.79	5	0.36	0.45			0	47,218.77	0	0.00
PSVK_NOR	1	0.08	3	2.26	1.09	0.00	100.00	0	100,818.50	1	682.02
PSVK_RUS	2	0.12	4	2.01	-0.12			0	14,611.70	1	446.73
Total in Basin	18	1.00	13	0.72	0.60	0.00	25.71	0	49,625.44	2	111.35

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PSVK_FIN	2	1	1		1	1	1	4	3	2	1	1	1	1	1
PSVK_NOR	1	1	1		2		2	3	3	2	1	1	1	1	1
PSVK_RUS	1	1	1		4		2	3	3	1	1	2	1	2	1
River Basin	2	1	1	2	2	1	1	4	2	2	1	1	1	1	1

Indicators

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Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
PSVK_FIN	4	5	1	1			1	1	1
PSVK_NOR	3	4	1	1			1	1	1
PSVK_RUS	2	3	1	1			1	1	1
River Basin	3	5	1	1	2	2	1	1	1

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Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
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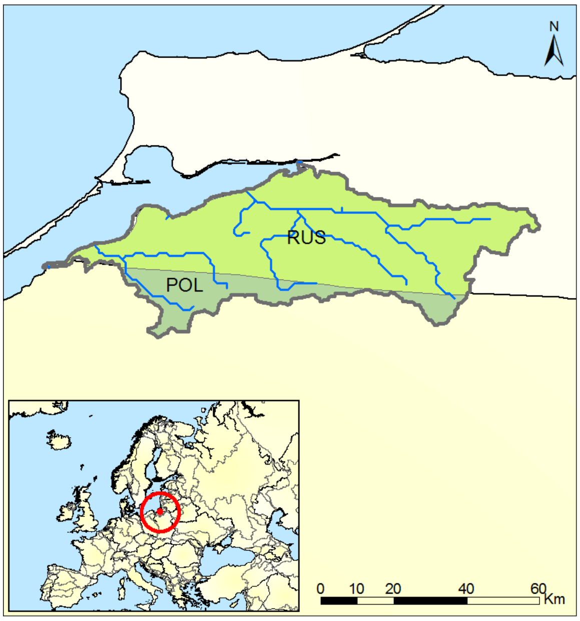
Prohladnaja Basin



Geography

Total drainage area (km^2)	1,791
No. of countries in basin	2
BCUs in basin	Poland (POL), Russian Federation (RUS)
Population in basin (people)	66,898
Country at mouth	Russian Federation
Average rainfall (mm/year)	765

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
PRLN_POL						
PRLN_RUS		347.84				
Total in Basin	0.62	347.84			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
PRLN_POL								
PRLN_RUS	33.25	2.57	1.30	0.00	9	20.54	555.62	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	33.25	2.57	1.30	0.00	8.85	20.54	497.06	5.34

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
PRLN_POL	0	0.19	7	20.46	0.06			0	13,431.95	0	0.00
PRLN_RUS	1	0.81	60	41.38	-0.12			0	14,611.70	0	0.00
Total in Basin	2	1.00	67	37.35	0.20	0.00	0.00	0	14,487.35	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
PRLN_POL					2				2	4	3	2	1	1	1
PRLN_RUS	1		2		4	1			2	3	3	2	1	2	2
River Basin	1		2	4	4				2	3	3	2	1	2	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
PRLN_POL									3
PRLN_RUS	2	2							3
River Basin	2	2			5	5			3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Basin Delineation
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Psou Basin

Geography

Total drainage area (km^2)	423
No. of countries in basin	2
BCUs in basin	Georgia (GEO), Russian Federation (RUS)
Population in basin (people)	24,577
Country at mouth	Georgia/ Russia
Average rainfall (mm/year)	1,719

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
PSOU_GEO						
PSOU_RUS		1,363.76				
Total in Basin	0.58	1,363.76			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
PSOU_GEO								
PSOU_RUS	31.35	0.00	1.37	0.00	14	16.13	1,732.68	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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Total in Basin	31.35	0.00	1.37	0.00	13.84	16.13	1,275.38	5.43

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
PSOU_GEO	0	0.52	6	29.38				0	3,602.17	0	0.00
PSOU_RUS	0	0.48	18	89.25				0	14,611.70	0	0.00
Total in Basin	0	1.00	25	58.04	0.08	0.00	0.00	0	11,706.01	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PSOU_GEO					5				4	3	3	4	1	2	1
PSOU_RUS	1		1		4				4	3	3	2	1	2	3
River Basin	1		1	4	5				3	3	3	3	1	3	3

Indicators

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Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
PSOU_GEO									3
PSOU_RUS	5	5							3
River Basin	5	5			4	4			3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Rezvaya Basin

Geography

Total drainage area (km^2)	771
No. of countries in basin	2
BCUs in basin	Bulgaria (BGR), Turkey (TUR)
Population in basin (people)	30,582
Country at mouth	Bulgaria, Turkey
Average rainfall (mm/year)	

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
REZV_BGR						
REZV_TUR						
Total in Basin					0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
REZV_BGR								
REZV_TUR								

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[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin									

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
REZV_ BGR	0	0.20	3	20.00	-0.64			0	7,296.49	0	0.00
REZV_ TUR	1	0.80	28	44.49	1.31			0	10,945.92	1	1,615.41
Total in Basin	1	1.00	31	39.67	1.08	0.00	0.00	0	10,583.19	1	1,297.02

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
REZV_BGR					4				3	4	2	1	1	1	1
REZV_TUR					3				3	4	2		1	2	1
River Basin				4	3				3	4	2		1	3	1

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
REZV_BGR									2
REZV_TUR									2
River Basin					4	4			2

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin					

3 Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Samur Basin

Geography

Total drainage area (km^2)	6,787
No. of countries in basin	2
BCUs in basin	Azerbaijan (AZE), Russian Federation (RUS)
Population in basin (people)	209,885
Country at mouth	Russian Federation
Average rainfall (mm/year)	550

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
SAMR_AZE						
SAMR_RUS		288.79				
Total in Basin	1.96	288.79			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
SAMR_AZE								
SAMR_RUS	212.51	108.19	4.71	0.00	38	61.45	1,155.33	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	212.51	108.19	4.71	0.00	38.17	61.45	1,012.52	10.84

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
SAMR_AZE	0	0.07	26	52.88	1.35			0	7,811.79	0	0.00
SAMR_RUS	6	0.93	184	29.22	-0.12			0	14,611.70	0	0.00
Total in Basin	7	1.00	210	30.93	0.36	0.00	0.00	0	13,771.17	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
SAMR_AZE					5	1			3	3	3	3	1	2	2
SAMR_RUS	2	2	2		4	2	2	1	3	3	3	2	1	2	3
River Basin	2	2	2	3	4	2	2	2	3	3	3	2	1	2	2

Indicators

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Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
SAMR_AZE									3
SAMR_RUS	4	5	2	2			1	1	3
River Basin	4	5	2	2	3	4	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

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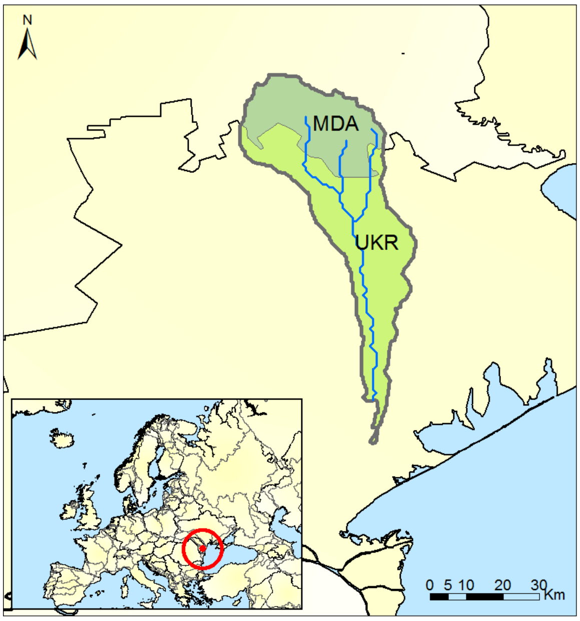
Sarata Basin



Geography

Total drainage area (km^2)	1,237
No. of countries in basin	2
BCUs in basin	Moldova, Republic Of (MDA), Ukraine (UKR)
Population in basin (people)	56,194
Country at mouth	Ukraine
Average rainfall (mm/year)	510

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
SRTA_MDA						
SRTA_UKR		107.97				
Total in Basin	0.13	107.97			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
SRTA_MDA								
SRTA_UKR	208.36	192.48	0.96	0.00	4	10.88	7,949.74	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	208.36	192.48	0.96	0.00	4.04	10.88	3,707.93	156.05

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
SRTA_MDA	0	0.35	30	68.92				0	2,229.62	0	0.00
SRTA_UKR	1	0.65	26	32.70	-0.64			0	3,900.47	0	0.00
Total in Basin	1	1.00	56	45.44	-0.11	0.00	0.00	0	3,008.94	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SRTA_MDA					4	3			3	3	3	4	1	1	1
SRTA_UKR	3	4	4		5		1	3	3	3	3	2	1	1	3
River Basin	3	5	4	3	4	2	3	3	3	3	3	3	1	1	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
SRTA_MDA									3
SRTA_UKR	4	4	5	5			1	1	3
River Basin	4	4	5	5	3	3	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	5				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Struma Basin

Geography

Total drainage area (km^2)	16,825
No. of countries in basin	4
BCUs in basin	Bulgaria (BGR), Greece (GRC), Serbia (SRB), The former Yugoslav Republic of Macedonia (MFD)
Population in basin (people)	945,538
Country at mouth	Greece
Average rainfall (mm/year)	589

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
STUM_BGR		274.70				
STUM_GRC		180.32				
STUM_MFD						
STUM_SRB						
Total in Basin	3.71	220.39			0.00	0.00

Water Withdrawals

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
STUM_BGR	442.18	126.84	1.30	229.32	45	40.13	950.37	
STUM_GRC	1,047.47	998.77	3.63	0.16	3	42.40	3,576.01	
STUM_MFD								
STUM_SRB								
Total in Basin	1,489.65	1,125.61	4.93	229.49	47.09	82.53	1,575.45	40.17

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
STUM_BGR	8	0.50	465	54.78	-0.64	0.00	100.00	0	7,296.49	2	235.46
STUM_GRC	6	0.36	293	48.68	0.31	58.76	41.24	0	21,910.22	0	0.00
STUM_MFD	2	0.10	122	74.59		0.00	100.00	0	4,850.51	2	1,226.82
STUM_SRB	1	0.04	66	96.24	0.00			0	5,935.32	0	0.00
Total in Basin	17	1.00	946	56.20	-0.47	18.20	74.84	0	11,414.43	4	237.74

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
STUM_BGR	2	4	2		4		4	3	3	4	5	1	1	1	2
STUM_GRC	3	5	5		1	1	4	2	3	3	3	3	2	1	1
STUM_MFD					5				3	4	3	5	1	2	2
STUM_SRB					5				3	4	1	4	1	2	1
River Basin	3	4	3	4	3	1	5	3	3	4	4	2	1	2	2

Indicators

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Very low | Low | Medium | High | Very high

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
STUM_BGR	3	4	4	4			1	1	5
STUM_GRC	4	5	5	5			1	1	3
STUM_MFD									3
STUM_SRB									1
River Basin	4	5	4	5	5	5	1	1	4

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	2				

Indicators

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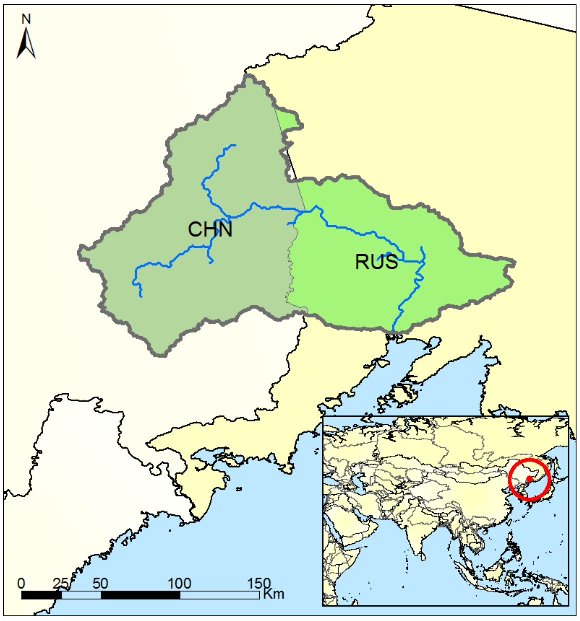
Sujfun Basin



Geography

Total drainage area (km^2)	16,820
No. of countries in basin	2
BCUs in basin	China (CHN), Russian Federation (RUS)
Population in basin (people)	501,469
Country at mouth	Russian Federation
Average rainfall (mm/year)	667

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
SUJF_CHN		97.51				
SUJF_RUS		175.29				
Total in Basin	2.46	146.23			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
SUJF_CHN	25.94	17.63	1.74	0.00	0	6.57	69.43	
SUJF_RUS	159.98	5.19	1.02	40.01	52	61.43	1,250.87	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	185.92	22.82	2.76	40.01	52.34	68.00	370.75	7.56

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
SUJF_CHN	10	0.60	374	37.27	0.51	0.00	100.00	0	6,807.43	0	0.00
SUJF_RUS	7	0.40	128	18.82	-0.12	0.00	100.00	1	14,611.70	0	0.00
Total in Basin	17	1.00	501	29.81	0.43	0.00	100.00	1	8,797.88	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SUJF_CHN	1	2	2		5	1	2	2	3	5	3	2	1	2	3
SUJF_RUS	1	1	2		4	4	1	2	4	3	3	2	1	2	3
River Basin	1	2	2	4	5	3	1	2	3	4	3	2	1	3	3

Indicators

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Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
SUJF_CHN	3	3	3	3			1	1	3
SUJF_RUS	2	3	2	2			1	1	3
River Basin	2	3	2	2	4	4	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

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Sulak Basin

Geography

Total drainage area (km^2)	14,108
No. of countries in basin	3
BCUs in basin	Azerbaijan (AZE), Georgia (GEO), Russian Federation (RUS)
Population in basin (people)	425,005
Country at mouth	Russian Federation
Average rainfall (mm/year)	641

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
SULK_AZE						
SULK_GEO						
SULK_RUS		231.53				
Total in Basin	3.27	231.53			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
SULK_AZE								

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[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

SULK_GEO								
SULK_RUS	358.67	170.66	8.27	0.00	79	100.90	888.41	
Total in Basin	358.67	170.66	8.27	0.00	78.84	100.90	843.91	10.98

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
SULK_AZE	0	0.00	0	50.94	1.35			0	7,811.79	0	0.00
SULK_GEO	1	0.07	21	21.88	-0.57			0	3,602.17	0	0.00
SULK_RUS	13	0.93	404	30.73	-0.12	0.00	100.00	0	14,611.70	2	152.21
Total in Basin	14	1.00	425	30.12	0.20	0.00	94.99	0	14,061.89	2	141.76

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
SULK_AZE					5	4			3	3	3	3	1	2	1
SULK_GEO					5	2			3	3	3	4	1	2	2
SULK_RUS	2	1	2		4	3	4	1	3	2	3	2	1	2	3
River Basin	2	1	2	4	4	3	4	2	3	2	3	2	1	3	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
SULK_AZE									3
SULK_GEO									3
SULK_RUS	3	5	1	2			1	1	3
River Basin	3	5	1	1	4	4	1	1	3

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Terek Basin

Geography

Total drainage area (km^2)	43,006
No. of countries in basin	2
BCUs in basin	Georgia (GEO), Russian Federation (RUS)
Population in basin (people)	3,939,188
Country at mouth	Russian Federation
Average rainfall (mm/year)	752

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
TERK_GEO						
TERK_RUS		363.34				
Total in Basin	15.63	363.34			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
TERK_GEO								
TERK_RUS	3,063.34	1,766.68	35.78	240.09	481	539.75	782.81	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	3,063.34	1,766.68	35.78	240.09	481.04	539.75	777.66	19.60

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
TERK_GEO	2	0.04	26	14.76	-0.57			0	3,602.17	0	0.00
TERK_RUS	41	0.96	3,913	94.87	-0.12	0.00	100.00	4	14,611.70	0	0.00
Total in Basin	43	1.00	3,939	91.60	0.22	0.00	99.34	4	14,539.17	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
TERK_GEO					5	5			4	3	3	4	1	2	2
TERK_RUS	2	3	2		4	3	3	2	3	2	3	2	2	2	2
River Basin	2	3	2	4	4	4	3	2	3	2	3	2	2	3	2

Indicators

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Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
TERK_GEO									3
TERK_RUS	3	4	3	3			1	1	3
River Basin	3	5	3	3	4	4	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Tuloma Basin

Geography

Total drainage area (km^2)	27,005
No. of countries in basin	2
BCUs in basin	Finland (FIN), Russian Federation (RUS)
Population in basin (people)	123,556
Country at mouth	Russian Federation
Average rainfall (mm/year)	610

Governance

No. of treaties and agreements[1]	2
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	4
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
TULM_FIN		370.63				
TULM_RUS		399.67			753.20	11.03
Total in Basin	10.73	397.21			753.20	11.03

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
TULM_FIN	0.22	0.00	0.02	0.00	0	0.21	162.10	
TULM_RUS	604.93	0.00	0.49	570.71	10	23.62	4,951.46	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	605.15	0.00	0.50	570.71	10.11	23.83	4,897.77	5.64

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
TULM_FIN	2	0.09	1	0.56	0.45			0	47,218.77	0	0.00
TULM_RUS	25	0.91	122	4.98	-0.12	0.00	100.00	1	14,611.70	1	40.78
Total in Basin	27	1.00	124	4.58	0.23	0.00	98.88	1	14,977.17	1	37.03

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
TULM_FIN	1	1	1		1		3	3	3	4	3	1	1	1	1
TULM_RUS	2	1	1		4	1	3	2	3	3	3	2	1	2	1
River Basin	2	1	1	1	4	1	3	2	2	3	3	2	1	2	1

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	**1.Environmental water stress**		**2.Human water stress**		**4.Nutrient pollution**		**16.Change in population density**		**11.Hydropolitical tension**
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
TULM_FIN	5	5	1	1			1	1	3
TULM_RUS	4	5	1	1			1	1	3
River Basin	4	5	1	1	1	1	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	3				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Tumen Basin

Geography

Total drainage area (km^2)	33,227
No. of countries in basin	3
BCUs in basin	China (CHN), Dem People's Rep of Korea (PRK), Russian Federation (RUS)
Population in basin (people)	2,601,640
Country at mouth	Russian Federation
Average rainfall (mm/year)	685

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	3

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
TUMN_CHN		159.83				
TUMN_PRK		213.98				
TUMN_RUS		213.41				
Total in Basin	6.09	183.18			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
TUMN_CHN	369.93	294.81	6.99	8.43	0	59.71	245.20	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

TUMN_PRK	257.94	191.16	2.30	64.48	0	0.00	236.68	
TUMN_RUS	16.60	3.35	0.23	0.00	4	8.80	5,331.04	
Total in Basin	644.47	489.31	9.52	72.90	4.23	68.51	247.72	10.59

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
TUMN_CHN	23	0.68	1,509	66.41	0.51	0.00	100.00	5	6,807.43	2	88.03
TUMN_PRK	10	0.31	1,090	104.91				0	0.00	1	96.26
TUMN_RUS	0	0.00	3	26.11	-0.12			0	14,611.70	0	0.00
Total in Basin	33	1.00	2,602	78.30	0.51	0.00	57.99	5	3,965.15	3	90.29

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
TUMN_CHN	2	2	2		5	2	3	2	3	5	4	2	1	2	3
TUMN_PRK	2	2	2		5	1	3	2	4	5	4	4	1	3	3
TUMN_RUS	1		2		4	5			4	3	4	2	1	2	4
River Basin	2	2	2	3	5	2	3	2	3	5	4	2	1	2	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
TUMN_CHN	2	2	3	3			1	1	4
TUMN_PRK	3	3	2	2			1	1	4
TUMN_RUS	2	3					1	1	4
River Basin	3	3	3	3	4	4	1	1	4

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment results: Water System Linkages

Thematic group	**Lake Influence Indicator**	**Delta Vulnerability Index**			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1				

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Vardar Basin

Geography

Total drainage area (km^2)	24,558
No. of countries in basin	4
BCUs in basin	Bulgaria (BGR), Greece (GRC), Serbia (SRB), The former Yugoslav Republic of Macedonia (MFD)
Population in basin (people)	2,125,676
Country at mouth	Greece
Average rainfall (mm/year)	624

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
VRDR_BGR						
VRDR_GRC		236.62				
VRDR_MFD		309.89				
VRDR_SRB		349.63				
Total in Basin	7.44	303.09			0.00	0.00

Water Withdrawals

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
VRDR_BGR								
VRDR_GRC	2,141.27	1,970.80	2.00	0.00	37	131.77	17,198.12	
VRDR_MFD	1,808.57	1,180.52	9.32	156.09	271	191.44	1,011.04	
VRDR_SRB	186.14	85.20	1.70	0.02	25	74.64	879.06	
Total in Basin	4,135.98	3,236.51	13.03	156.11	332.48	397.85	1,945.72	55.57

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
VRDR_BGR	0	0.00	1	57.42	-0.64			0	7,296.49	0	0.00
VRDR_GRC	3	0.12	125	42.94	0.31	76.42	23.58	0	21,910.22	0	0.00
VRDR_MFD	20	0.83	1,789	87.58		0.00	100.00	1	4,850.51	4	195.83
VRDR_SRB	1	0.05	212	173.29	0.00			0	5,935.32	0	0.00
Total in Basin	25	1.00	2,126	86.56	-0.02	4.48	85.53	1	5,958.49	4	162.88

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
VRDR_BGR					4				2	4	3	1	1	1	1
VRDR_GRC	4	5	5		1	3	4	2	3	3	4	3	3	1	2
VRDR_MFD	2	3	3		5		5	2	3	4	5	5	5	2	3
VRDR_SRB	2	4	3		5		5	4	2	4	4	4	1	2	1
River Basin	3	4	3	4	5	1	5	3	2	4	5	5	5	2	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
VRDR_BGR									3
VRDR_GRC	5	5	5	5			1	1	4
VRDR_MFD	3	4	4	4					5
VRDR_SRB	3	3	5	5			2	3	4
River Basin	3	4	4	5	4	5	1	2	5

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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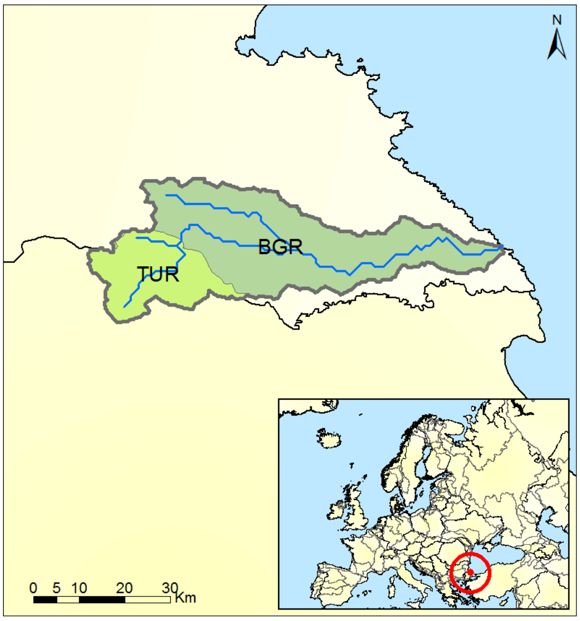
Velaka Basin



Geography

Total drainage area (km^2)	1,075
No. of countries in basin	2
BCUs in basin	Bulgaria (BGR), Turkey (TUR)
Population in basin (people)	20,475
Country at mouth	Bulgaria
Average rainfall (mm/year)	665

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
VLKA_BGR		211.33				
VLKA_TUR		193.80				
Total in Basin	0.22	205.50			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
VLKA_BGR	68.09	46.26	0.96	6.78	3	11.07	8,722.98	
VLKA_TUR	76.21	57.90	0.48	0.00	8	9.54	6,015.19	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	144.30	104.16	1.44	6.78	11.32	20.60	7,047.41	65.30

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
VLKA_BGR	1	0.73	8	9.94	-0.64			0	7,296.49	0	0.00
VLKA_TUR	0	0.27	13	43.69	1.31			0	10,945.92	0	0.00
Total in Basin	1	1.00	20	19.04	0.56	0.00	0.00	0	9,554.74	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
VLKA_BGR	2		2		4				3	4	3	1	1	1	2
VLKA_TUR	2		3		3				3	5	3		1	2	2
River Basin	2		2	3	3				3	4	3		1	2	2

Indicators

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Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
VLKA_BGR	3	4					1	1	3
VLKA_TUR	3	4							3
River Basin	3	4			3	4	1	1	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

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Indicators

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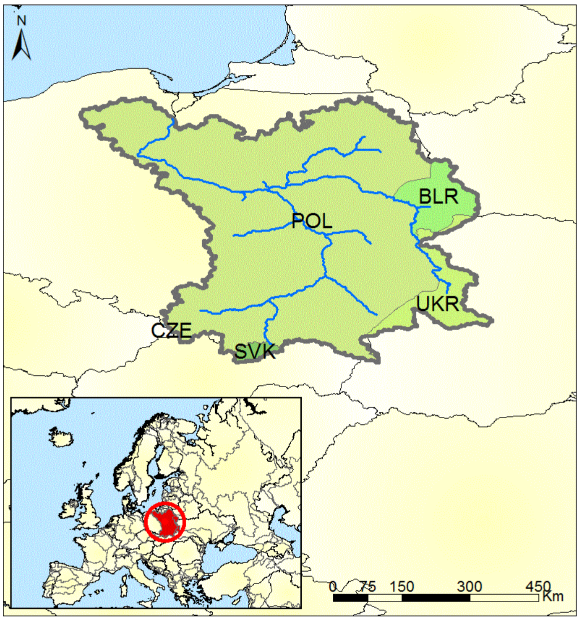
Vistula/Wista Basin



Geography

Total drainage area (km^2)	192,043
No. of countries in basin	5
BCUs in basin	Belarus (BLR), Czech Republic (CZE), Poland (POL), Slovakia (SVK), Ukraine (UKR)
Population in basin (people)	23,147,770
Country at mouth	Poland
Average rainfall (mm/year)	678

Governance

No. of treaties and agreements[1]	6
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
VSTL_BLR		122.36				
VSTL_CZE						
VSTL_POL		180.44			122.20	0.73
VSTL_SVK		443.78				
VSTL_UKR		156.01				
Total in Basin	34.61	180.22			122.20	0.73

Water Withdrawals

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BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
VSTL_BLR	167.57	13.84	1.37	1.28	67	83.74	282.63	
VSTL_CZE								
VSTL_POL	7,033.52	132.46	112.36	4,310.45	899	1,579.07	334.98	
VSTL_SVK	84.75	0.42	1.64	0.00	58	24.57	450.25	
VSTL_UKR	413.44	0.71	1.65	179.74	106	124.91	301.88	
Total in Basin	7,699.28	147.43	117.02	4,491.47	1,131.07	1,812.29	332.61	22.25

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
VSTL_BLR	10	0.05	593	58.60	-0.47	0.00	100.00	1	7,575.48	0	0.00
VSTL_CZE	0	0.00	1	128.25	0.53			0	18,861.43	0	0.00
VSTL_POL	167	0.87	20,997	125.57	0.06	0.00	100.00	20	13,431.95	19	113.63
VSTL_SVK	2	0.01	188	96.29	0.17	0.00	100.00	0	17,689.04	0	0.00
VSTL_UKR	13	0.07	1,370	107.32	-0.64	0.00	100.00	1	3,900.47	0	0.00
Total in Basin	192	1.00	23,148	120.53	-0.02	0.00	100.00	22	12,752.75	19	98.94

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
VSTL_BLR	1	2	2		1	1	3	3	2	2	2		1	1	2
VSTL_CZE					2				2	3	2	1	1	1	1
VSTL_POL	2	4	2		2	2	4	3	3	2	2	2	4	1	3
VSTL_SVK	1	1	2		3	3	5	3	2	3	2	2	1	1	2
VSTL_UKR	1	3	2		5		4	3	2	2	1	2	1	1	2
River Basin	2	3	2	4	3	2	4	4	2	2	2	2	4	2	3

Indicators

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Very low	Low	Medium	High	Very high

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Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
VSTL_BLR	2	2	3	3			1	1	2
VSTL_CZE									2
VSTL_POL	2	2	4	4			1	1	2
VSTL_SVK	3	3	1	1			1	1	2
VSTL_UKR	3	3	4	4			1	1	1
River Basin	2	2	4	4	4	5	1	1	2

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Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
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Volga Basin

Geography

Total drainage area (km^2)	1,411,749
No. of countries in basin	2
BCUs in basin	Kazakhstan (KAZ), Russian Federation (RUS)
Population in basin (people)	58,620,871
Country at mouth	Russian Federation
Average rainfall (mm/year)	644

Governance

No. of treaties and agreements[1]	3
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	25
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
VOLG_KAZ		61.53				
VOLG_RUS		194.54			23,893.30	165.91
Total in Basin	274.16	194.20			23,893.30	165.91

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
VOLG_KAZ	7.69	5.22	0.52	0.00	0	1.95	1,011.74	
VOLG_RUS	24,996.19	2,574.63	265.06	8,879.75	6,042	7,235.05	426.46	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	25,003.88	2,579.85	265.57	8,879.75	6,041.70	7,237.00	426.54	9.12

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
VOLG_KAZ	1	0.00	8	5.14				0	13,171.81	0	0.00
VOLG_RUS	1,410	1.00	58,613	41.56	-0.12	0.00	100.00	74	14,611.70	17	12.05
Total in Basin	1,412	1.00	58,621	41.52	0.22	0.00	99.99	74	14,611.51	17	12.04

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
VOLG_KAZ	3	1	2		4	2	3	4	3	3	2	3	1	2	2
VOLG_RUS	2	1	2		4	2	4	4	4	3	2	2	4	2	3
River Basin	2	1	2	2	4	2	4	4	3	3	2	2	4	3	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
VOLG_KAZ	5	5	1	1					2
VOLG_RUS	4	4	2	2			1	1	2
River Basin	4	5	2	2	2	3	1	1	2

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	2	1	5	1	4

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Vuoksa Basin

Geography

Total drainage area (km^2)	287,094
No. of countries in basin	3
BCUs in basin	Belarus (BLR), Finland (FIN), Russian Federation (RUS)
Population in basin (people)	3,246,181
Country at mouth	Russian Federation
Average rainfall (mm/year)	695

Governance

No. of treaties and agreements[1]	5
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	62
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
VUKS_BLR		247.74				
VUKS_FIN		321.80			8,814.30	123.33
VUKS_RUS		299.18			30,535.70	1,132.35
Total in Basin	87.40	304.43			39,350.00	1,255.68

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
VUKS_BLR	2.81	0.26	0.40	0.00	0	2.15	599.84	

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VUKS_FIN	288.81	27.75	6.71	4.74	176	73.80	345.40	
VUKS_RUS	5,298.42	17.26	18.56	4,351.03	400	511.57	2,202.78	
Total in Basin	5,590.04	45.26	25.67	4,355.77	575.82	587.52	1,722.03	6.40

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
VUKS_ BLR	0	0.00	5	10.09				0	7,575.48	0	0.00
VUKS_ FIN	64	0.22	836	13.09	0.45	10.97	89.03	0	47,218.77	5	78.29
VUKS_ RUS	223	0.78	2,405	10.80	-0.12	0.00	100.00	5	14,611.70	3	13.47
Total in Basin	287	1.00	3,246	11.31	0.29	2.83	97.03	5	23,000.59	8	27.87

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
VUKS_BLR	1	1	2		1	1	2	1	2	3	3		1	1	2
VUKS_FIN	2	1	2		1		5	3	3	2	1	1	4	1	1
VUKS_RUS	2	1	2		4	2	4	2	3	1	1	2	1	2	2
River Basin	2	1	2	3	4	2	4	2	2	2	1	2	2	2	1

Indicators

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Very low	Low	Medium	High	Very high

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Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
VUKS_BLR	2	2	1	1					3
VUKS_FIN	2	3	1	1			1	1	1
VUKS_RUS	3	3	1	1			1	1	1
River Basin	3	3	1	1	3	3	1	1	1

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TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	5				

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1. LME 01 - East Bering Sea
2. LME 20 - Barents Sea
3. LME 50 - Sea of Japan
4. LME 52 - Sea of Okhotsk
5. LME 53 - West Bering Sea
6. LME 54 - Chukchi Sea
7. LME 55 – Beaufort Sea
8. LME 56 – East Siberian Sea
9. LME 57 – Laptev Sea
10. LME 58 – Kara Sea
11. LME 62 – Black Sea
12. LME 64 – Central Arctic

United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission

GESAMP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection

Center for Marine Assessment and Planning, UCSB

DALHOUSIE UNIVERSITY *Inspiring Minds*

GLOBAL IGBP CHANGE International Geosphere-Biosphere Programme

UNEP WCMC

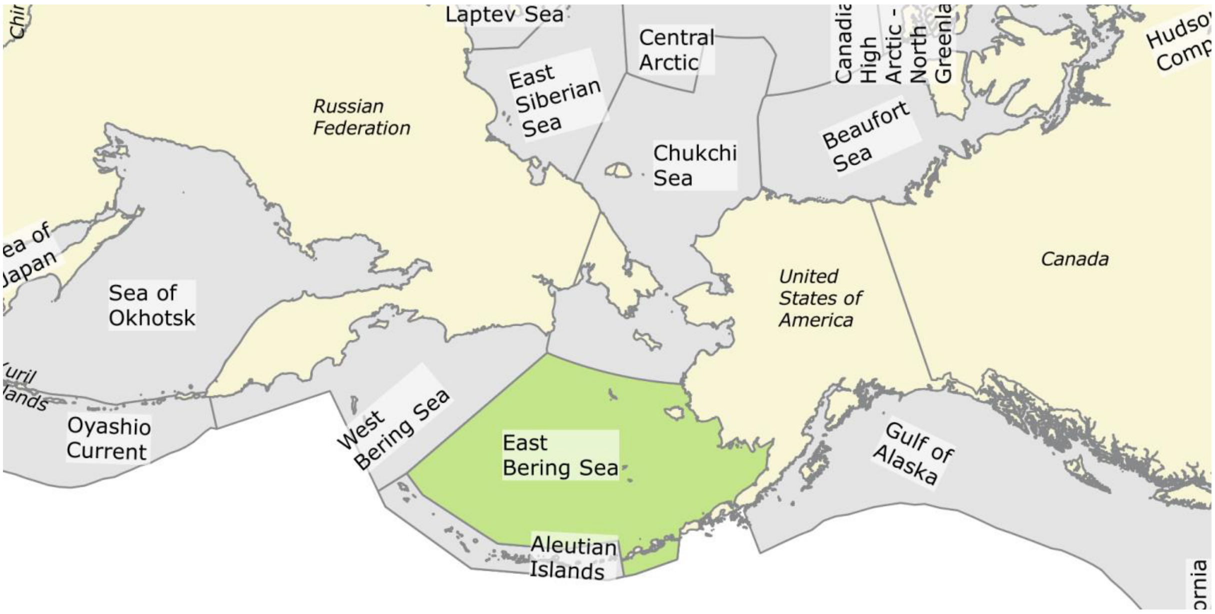
UBC

SEA AROUND US

CERMES

TAT Tokyo University of Agriculture and Technology

LME 01 – East Bering Sea



Bordering country: United States of America
LME Total area: 1,193,601 km^2

List of indicators

LME overall risk

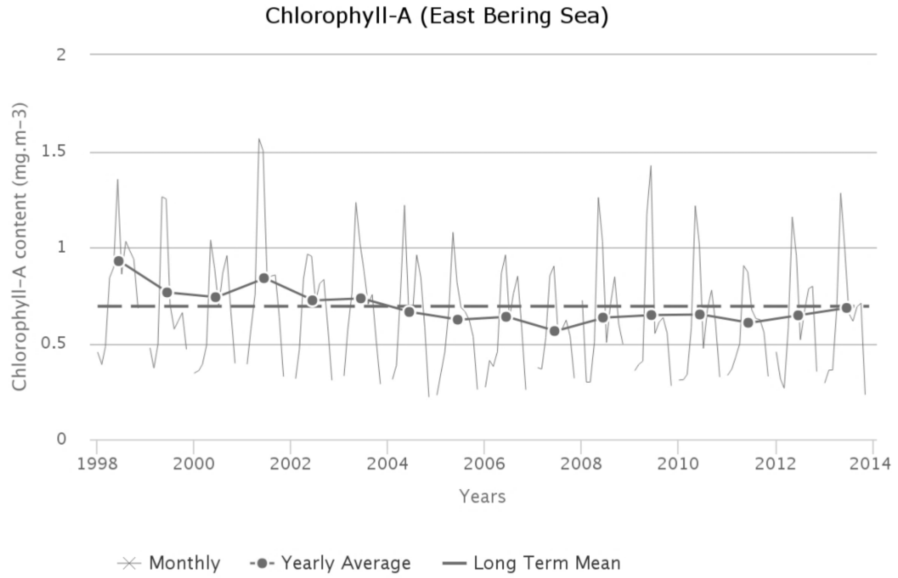
This LME falls in the cluster of LMEs that exhibit medium numbers of collapsed and overexploited fish stocks, as well as very high proportions of catch from bottom impacting gear.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is medium.

Very low | Low | Medium | High | Very high

Productivity

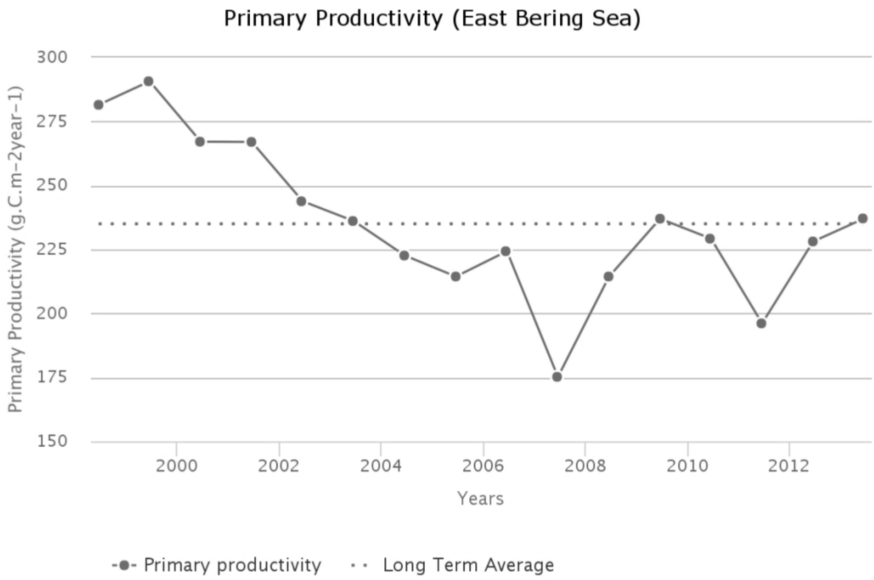
Chlorophyll-A

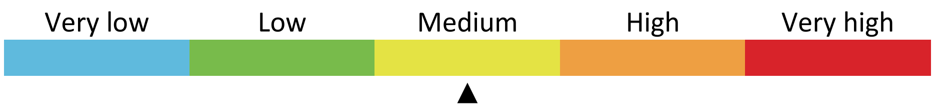
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (1.12 mg.m^{-3}) in May and a minimum (0.309 mg.m^{-3}) during November. The average CHL is 0.692 mg.m^{-3}. Maximum primary productivity (291 g.C.m^{-2}.y^{-1}) occurred during 1999 and minimum primary productivity (175 g.C.m^{-2}.y^{-1}) during 2007. There is a statistically insignificant decreasing trend in Chlorophyll of -19.1 % from 2003 through 2013. The average primary productivity is 235 g.C.m^{-2}.y^{-1}, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).



Very low | Low | Medium | High | Very high

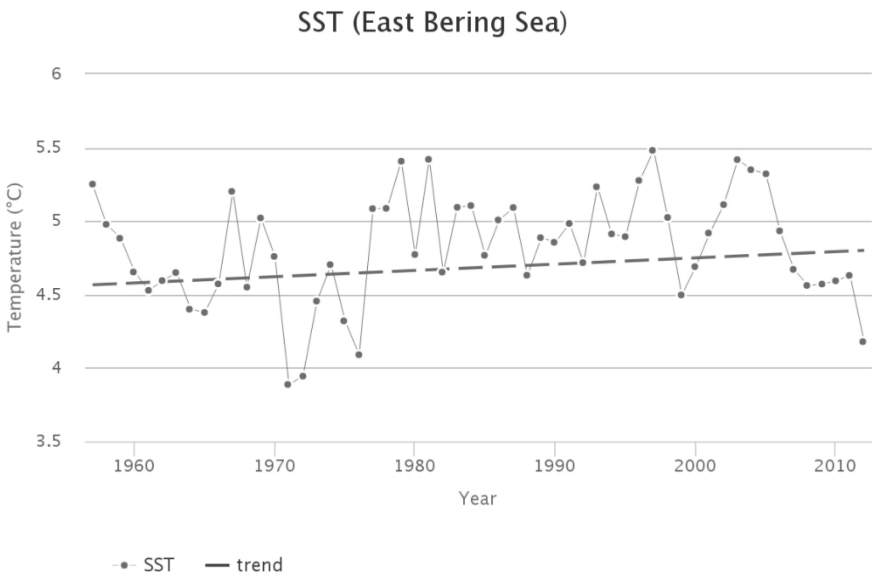
Primary productivity





Sea Surface Temperature

Between 1957 and 2012, the East Bering Sea LME #1 has warmed by 0.24°C. It thus belongs to Category 4 (slow-warming LME). The 1957-2012 time span included periods with opposite SST trends. From 1957 through 1971 SST decreased by >1°C. The SST drop was especially abrupt in the late 1960s-early 1970s. The cold spell lasted through 1976, after which SST jumped by ~1°C in one year and remained relatively high through 2003. The 1°C SST jump from 4°C to 5°C between 1976 and 1977 was a manifestation of a "regime shift" in the North Pacific that occurred during the winter of 1976-1977, caused by a large-scale shift of the North Pacific atmospheric pressure pattern (Hare and Mantua, 2000). After peaking at 5.5°C in 1998 and at 5.4°C in 2003, SST plunged below 4.2°C by 2012, a drop of 1.2°C in 9 years.

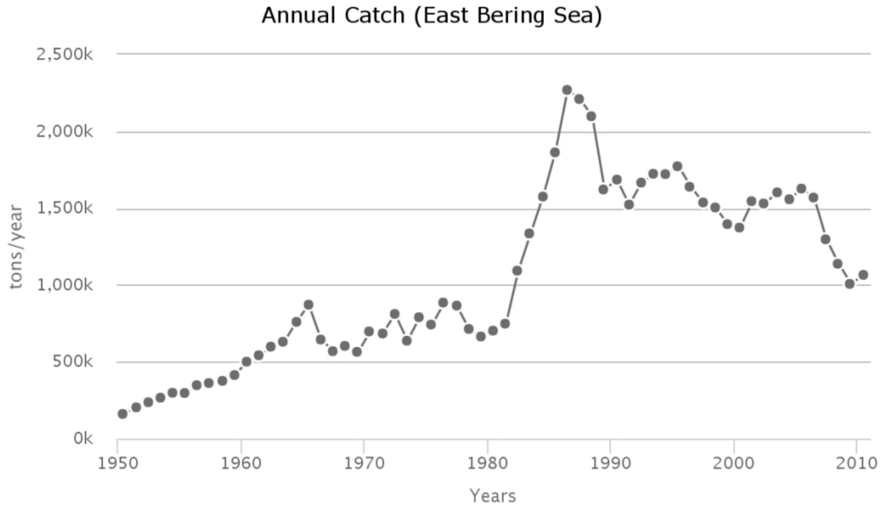


Fish and Fisheries

The East Bering Sea LME supports the world's largest single-species fishery, targeting Alaska pollock (*Theragra chalcogramma*).

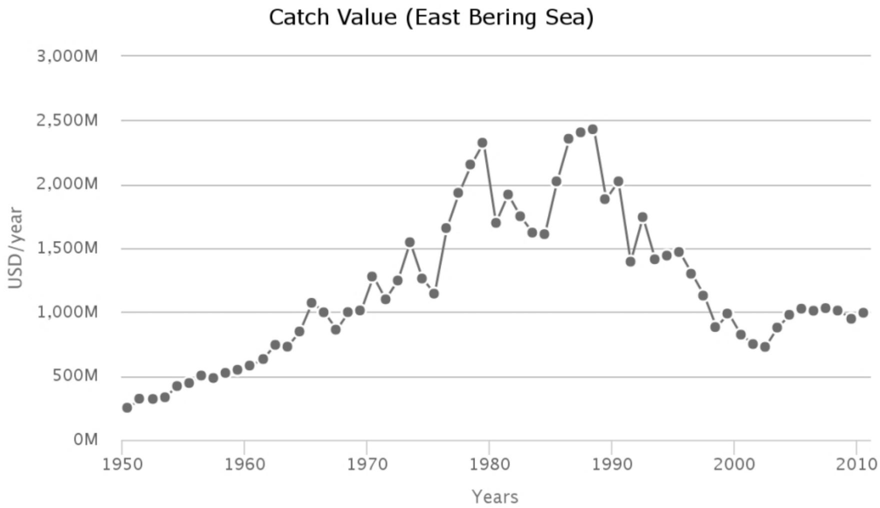
Annual Catch

Reported landings of this fishery now range between 0.4 and 0.7 million t, a level thought to be sustainable. Other commercially valuable species include halibut, herring, capelin, Pacific cod, skate, flounder, Greenland turbot, sole, dab, plaice and crab. Total reported landings rose steadily to a historic high of 1.8 million t in 1986, followed by a decline to 1.1million t in the mid-2000s and then followed by a further decline to 0.9 million t in the recent years.



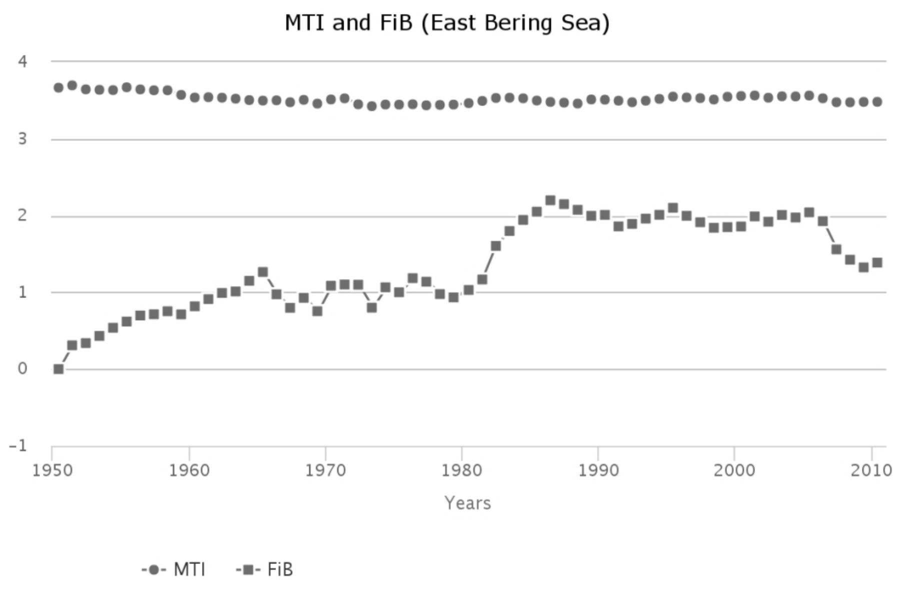
Catch value

The value of the fishery reached its peak at 1.9 billion US$ (in 2005 US$) in 1979.



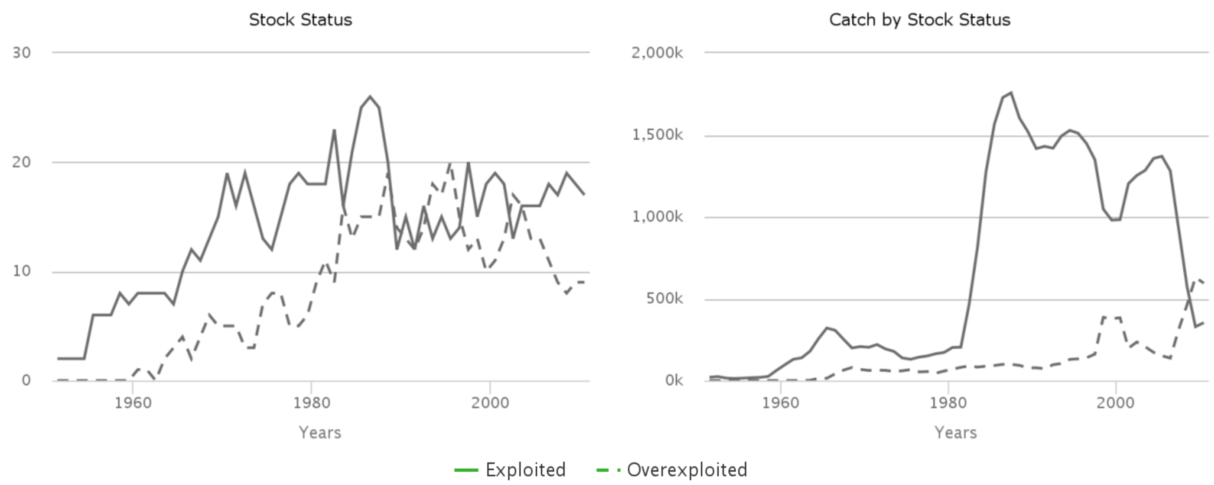
Marine Trophic Index and Fishing-in-Balance index

The MTI declined from the 1950s to the early 1970s, but has since leveled off at around 3.5 due to the enormous catch of Alaska pollock. The geographic expansion which led to this dominance of Alaska pollock is suggested by the increase of the FiB index from the mid-1970s to the mid-1980s. The system appears sustainable according to these two indices, although it must be stressed that such an interpretation is based on the overwhelming effect of a single, well-managed species.



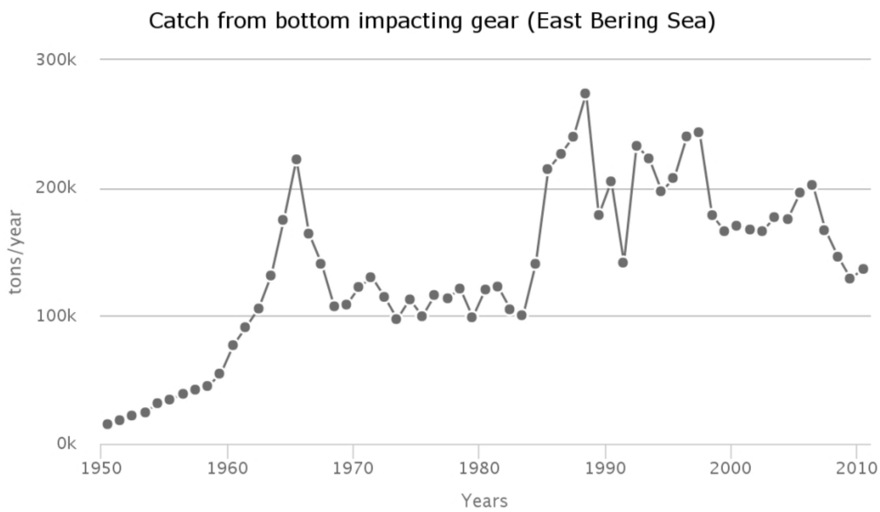
Stock status

The Stock-Catch Status Plots indicate that about 40% of the commercially exploited stocks have collapsed. The majority of the reported landings is still supplied by overexploited stocks, or more specifically, by Alaska pollock.



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch reaches its maximum at 19% in 1965 and then this percentage ranges between 6 to 13% in the recent few decades.

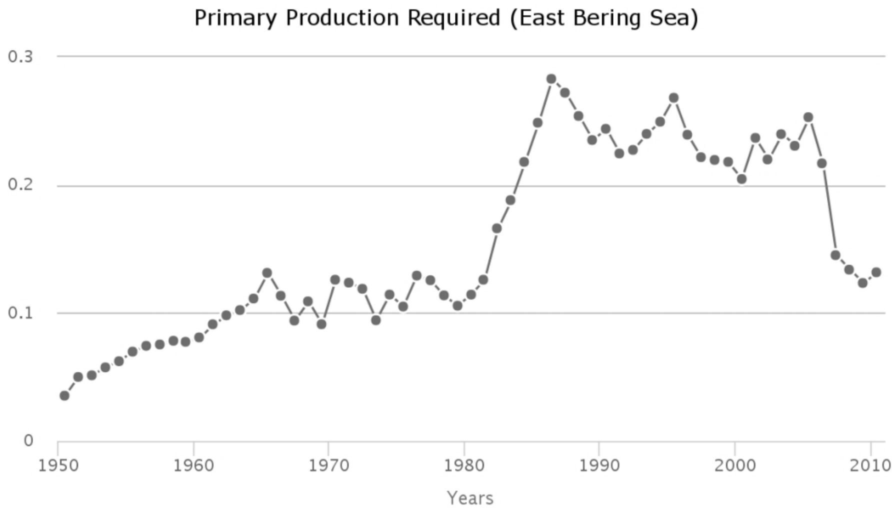


Fishing effort

The total effective effort fluctuated around 20 million kW from 1950 to 1980 and started to increase since the 1980s. It keeps increasing continuously in the last few decades and reaches its maximum in 2005 at 56 million kW.

Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME reached 25% of the observed primary production in the mid of the 1980s, and has dropped to less than 15% in recent years.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular nitrogen load) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the ratio of nutrients entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans. An overall nutrient indicator (Merged Nutrient Indicator) based on 2 sub-indicators: Nitrogen Load and Nutrient Ratio (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a “current trends” scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

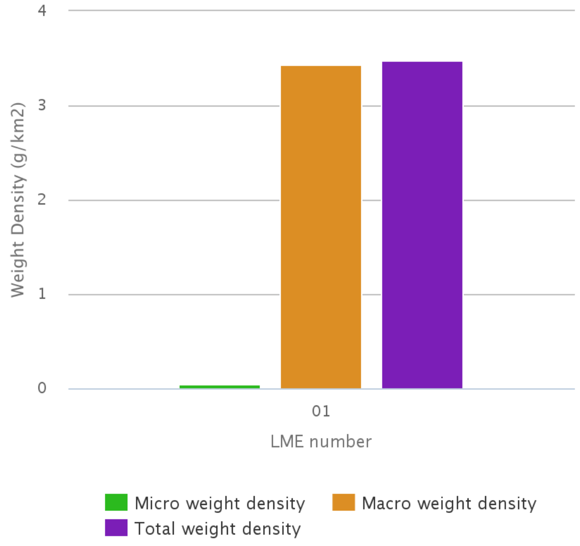
2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	2	1	1	2	1	1	2	1

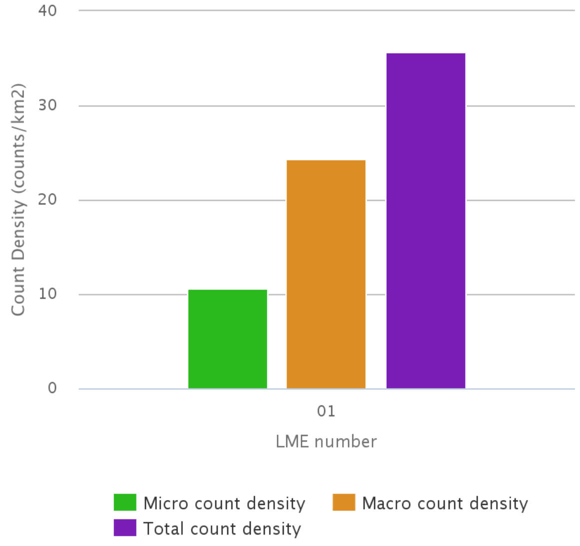
Legend:

Very low Low Medium High Very high

POPs
No pellet samples were obtained from this LME.

Plastic debris
Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the lowest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The low values are due to the remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be over 400 times lower than those LMEs with the highest values. There is very limited evidence from sea-based direct observations and towed nets to support this conclusion.





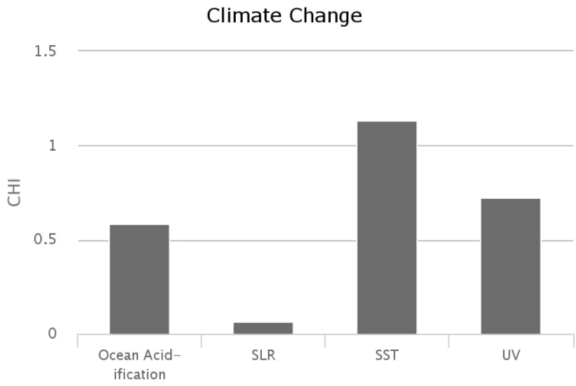
Ecosystem Health

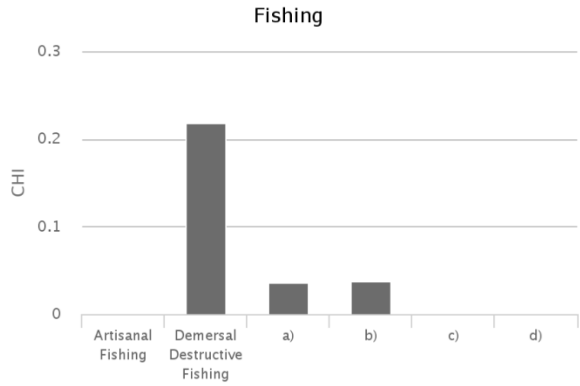
Mangrove and coral cover
Not applicable

Reefs at risk
Not applicable

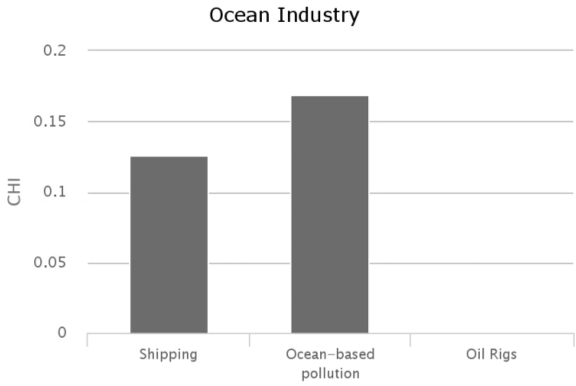
Marine Protected Area change
The East Bering Sea LME experienced an increase in MPA coverage from 13,228 km2 prior to 1983 to 122,905 km2 by 2014. This represents an increase of 829%, within the low category of MPA change.

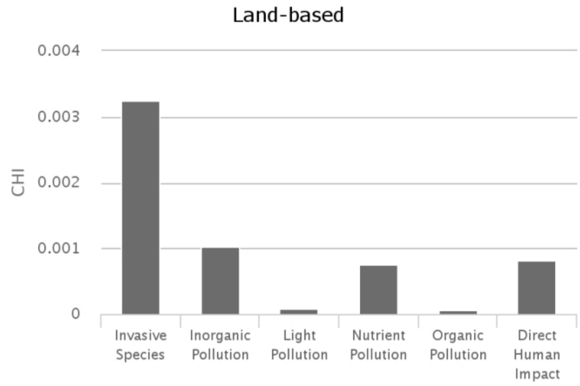
Cumulative Human Impact
The East Bering Sea LME experiences an average overall cumulative human impact (score 3.1; maximum LME score 5.22), but which is still well above the LME with the least cumulative impact. It falls in risk category 2 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is particularly vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: sea surface temperature (1.13; maximum in other LMEs was 2.16), UV radiation (0.73; maximum in other LMEs was 0.76), and ocean acidification (0.58; maximum in other LMEs was 1.20). Other key stressors include commercial shipping, ocean based pollution, and demersal destructive commercial fishing.

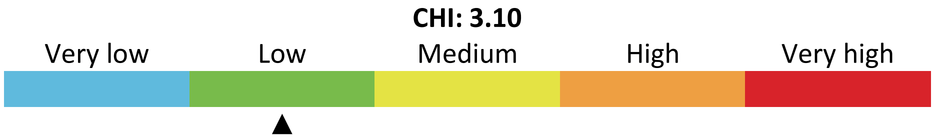




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

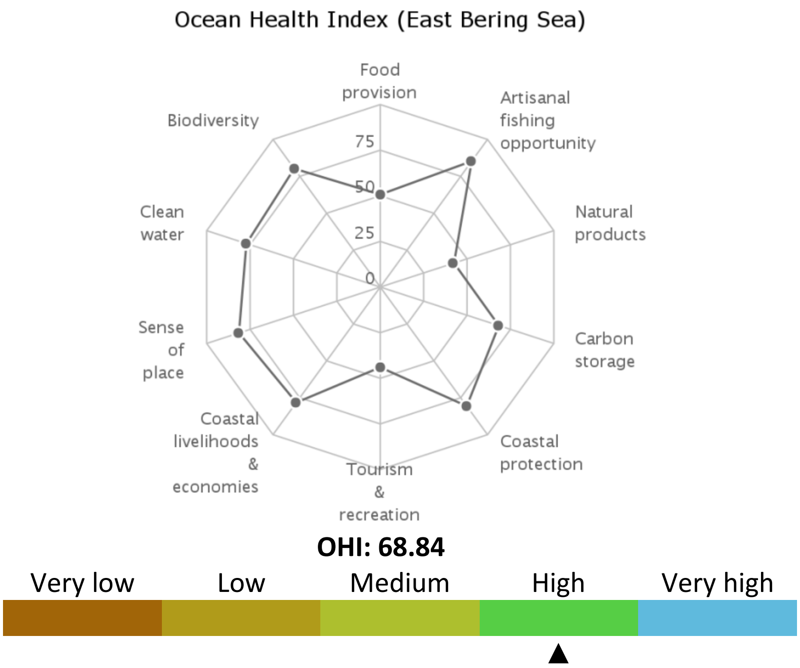






Ocean Health Index

The East Bering Sea LME scores above average on the Ocean Health Index compared to other LMEs (score 72 out of 100; range for other LMEs was 57 to 82) but still relatively low. This score indicates that the LME is well below its optimal level of ocean health, although there are many aspects that are doing well. Its score in 2013 increased by 9 points compared to the previous year, due in large part to changes in the scores for clean waters and natural products goals. This LME scores lowest on mariculture, tourism & recreation and natural products goals, and highest on artisanal fishing opportunities, coastal protection, coastal economies, lasting special places, and species diversity goals. It falls in risk category 2 of the five risk categories, which is a moderate level of risk (1 = lowest risk; 5 = highest risk).



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for the East Bering Sea LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coast includes the southwest fringe of the Alaskan Peninsula and is among the most sparsely populated (lowest risk) and completely rural of LMEs. It covers 140,753 km^2, with a density of 1 person every 4 km^2 in 2010 and decreasing to 1 person every 5 km^2 in 2100.

Total population		Rural population	
2010	2100	2010	2100
33,447	26,429	33,447	26,429

Legend: Very low | Low | Medium | High | Very high

Coastal poor

The indigent population makes up 17% of the LME's coastal dwellers. This LME places in the high-risk category based on percentage of poor but among those with the lowest absolute number of poor at 5700 (present day estimate).

Coastal poor
5,732

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. The East Bering Sea LME ranks in the high revenue category in fishing revenues based on yearly average total ex-vessel price of US

2013 $1.15 billion (thousand million) for the period 2001-2010. Fish protein accounts for 7% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013 $4.2 billion places it in the low revenue category. On average, LME-based tourism income contributes 8% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for the East Bering Sea LME falls in the category with lowest risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
1,151,820,959	7.4	4,240,125,385	8.4	0.6022

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day East Bering Sea LME HDI belongs to the highest HDI and lowest risk category. Based on an HDI of 0.909, this LME has an HDI Gap of 0.091, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). The East Bering Sea LME is projected to maintain its position in the lowest risk category (highest HDI) in 2100 under a sustainable development pathway or scenario. Under a fragmented world scenario, this LME is projected to slip to the high risk category (low HDI) because of reduced income level and bigger population size compared to estimated income and population values in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.9094	0.9662	0.6971

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (*e.g.* overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of

warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.
Present day climate threat to the East Bering Sea LME is within the low risk (low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very low. Regardless of development pathway, this LME is projected to belong to the lowest risk category that is least threatened by sea level rise in 2100.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.4210	0.2348	0.2127	0.4336

Legend:

Very low | Low | Medium | High | Very high

Governance

Governance architecture

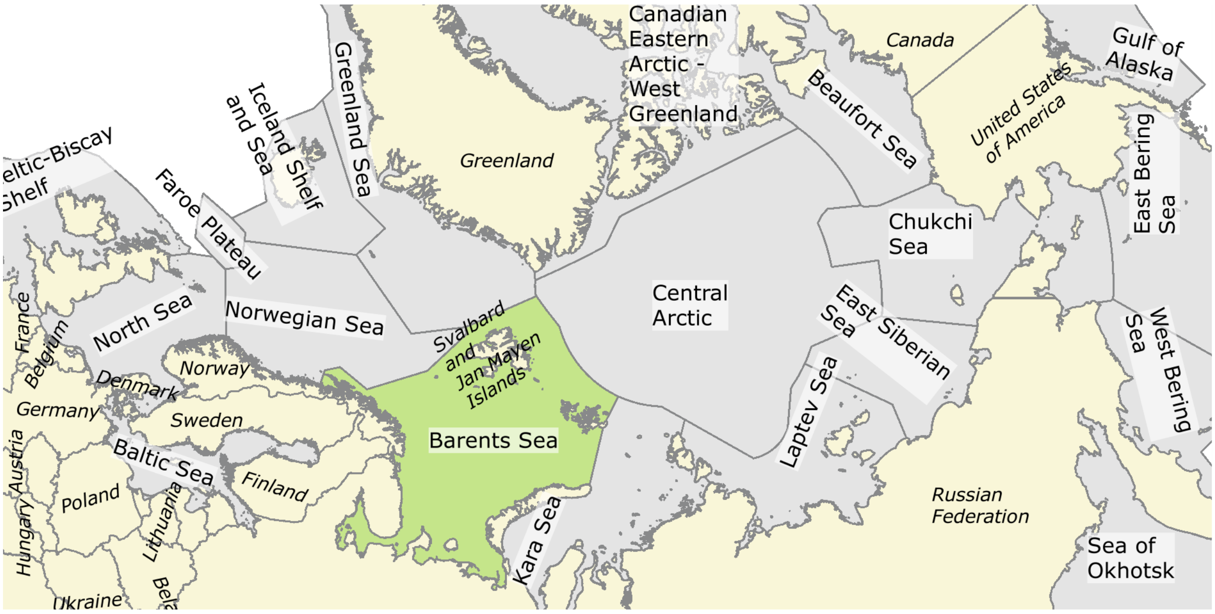
The four fisheries arrangements in this LME - NPAFC, CCBSP, IPHC and WCPFC - are unique in addressing specific types of fisheries. The only area for commonality appears to be in the form of scientific advice being provided with input from PICES in arrangements relating to halibut, pollock and anadromous species. Additionally, the member countries are primarily responsible for implementation across all of the arrangements. The Arctic Council provides for some level of integration across pollution (LBS and MBS) and for biodiversity (general) in the part of the LME that is covered by the Arctic Council. However, overall, no integrating mechanisms, such as an overall policy coordinating organisation for the LME, could be found. There may be interaction amongst the arrangements through participation in each other's meetings, but this appears to be informal.
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
83	**70**	**0.1**

Legend:

Very low | Low | Medium | High | Very high

LME 20 – Barents Sea



Bordering countries: Norway, Russia, Svalbard
LME Total area: 2,023,335 km^2

Contents

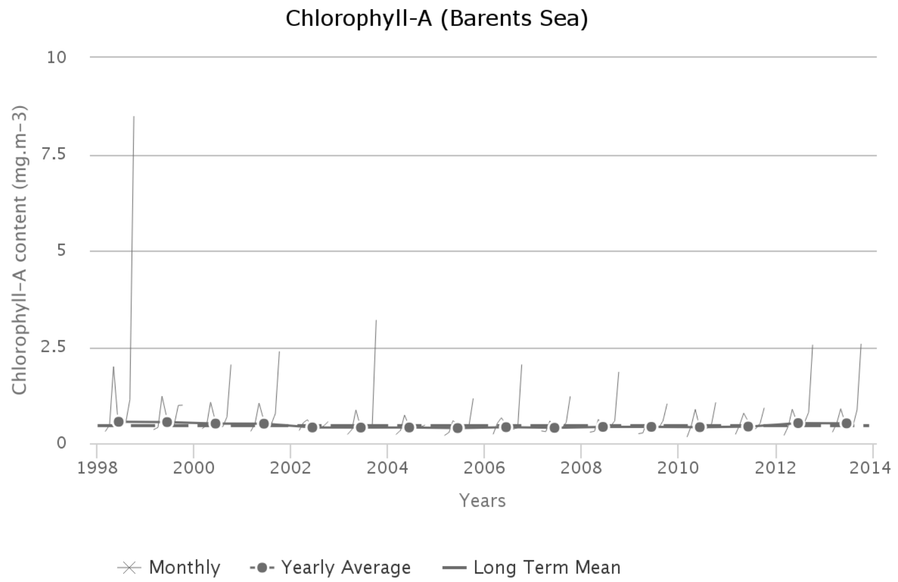
LME overall risk

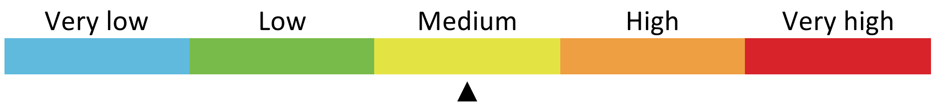
Results unavailable.

Productivity

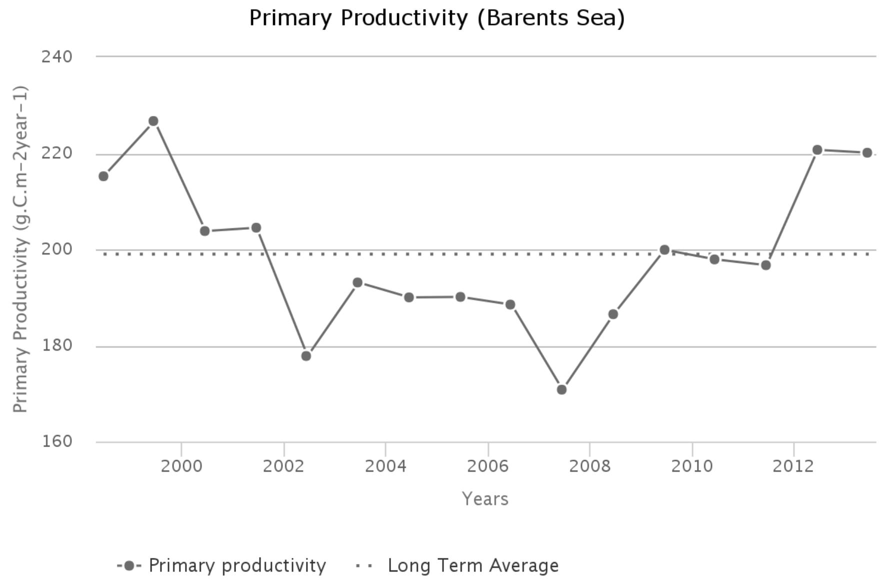
Chlorophyll-A

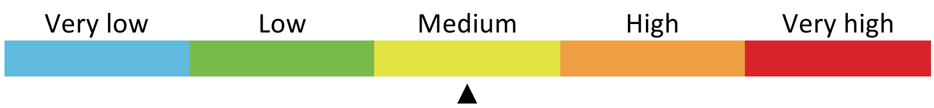
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (1.14 mg.m^{-3}) in October and a minimum (0.267 mg.m^{-3}) during March. The average CHL is 0.455 mg.m^{-3}. Maximum primary productivity (227 g.C.m^{-2}.y^{-1}) occurred during 1999 and minimum primary productivity (171 g.C.m^{-2}.y^{-1}) during 2007. There is a statistically insignificant increasing trend in Chlorophyll of 8.90 % from 2003 through 2013. The average primary productivity is 199 g.C.m^{-2}.y^{-1}, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).





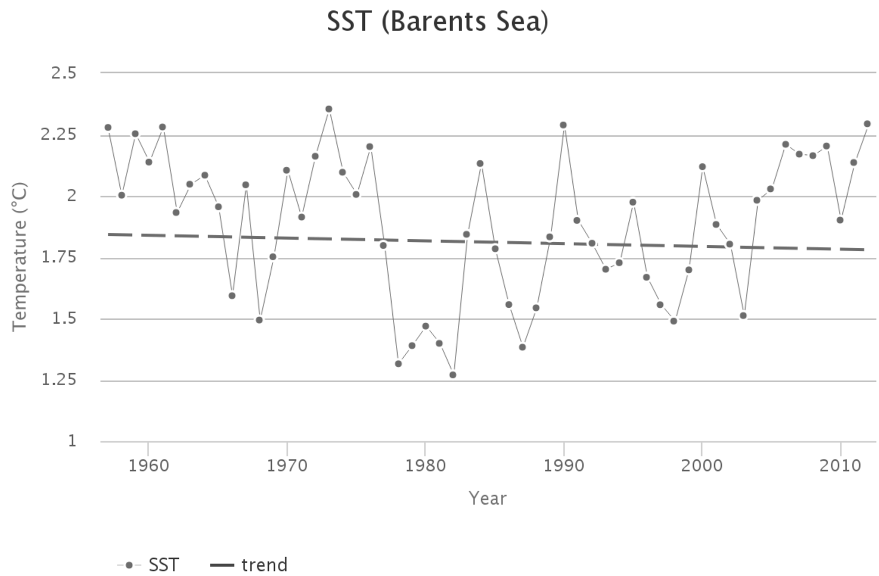
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Barents Sea LME #20 has cooled by 0.06°C, thus belonging to Category 5 (cooling LME). In the long-term, the Barents Sea LME appears relatively stable, although interannual variations of its SST are substantial, having a magnitude of 1°C. The timing of cold events of 1978-79, 1987, and 1997-99 is consistent with the well-documented passages of the decadal-scale Great Salinity Anomalies (Dickson et al., 1988; Belkin et al., 1998; Belkin, 2004) of the 1970s, 1980s, and 1990s through the Barents Sea. A few warming events are also noteworthy. The last warming event, of 2000, was concurrent with a sharp maximum in the Norwegian Sea LME #21. The previous SST peak of 1974 in the Norwegian Sea may have been related to the Barents Sea SST peak of 1973.



Fish and Fisheries

Results are unavailable for this LME.

Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans. An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was low (level 2 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
2	3	2	2	3	2	2	3	2

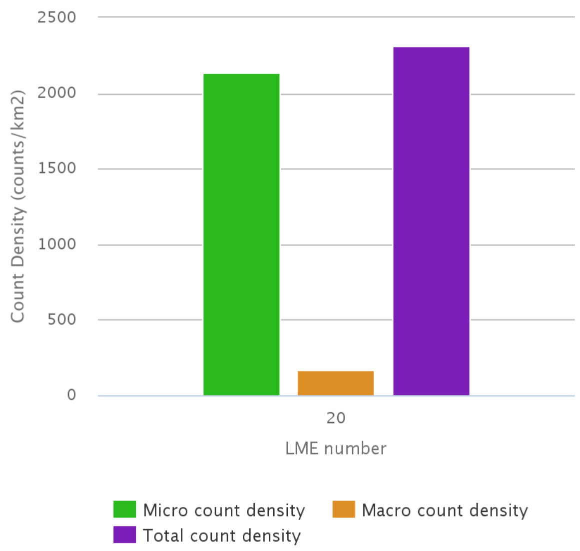
Legend: Very low, Low, Medium, High, Very high

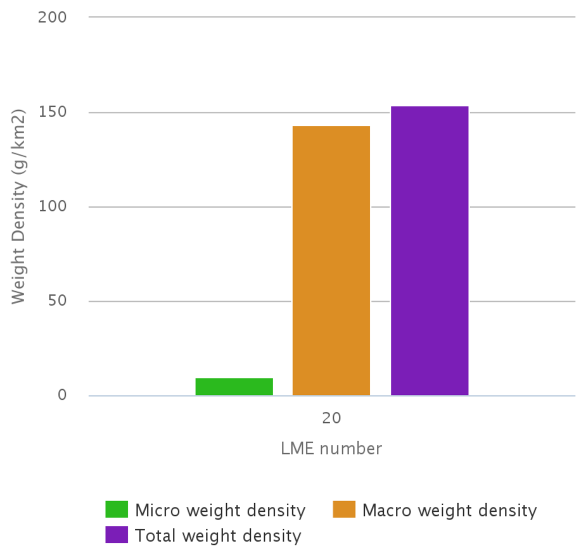
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively moderate levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to the relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 12 times lower that those LMEs with lowest values. There is very limited evidence from sea-based direct observations and towed nets to support this conclusion.





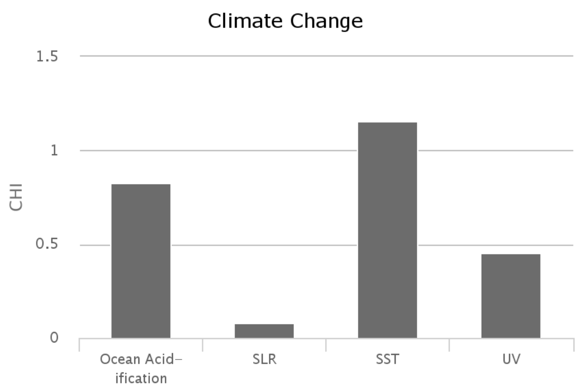
Ecosystem Health

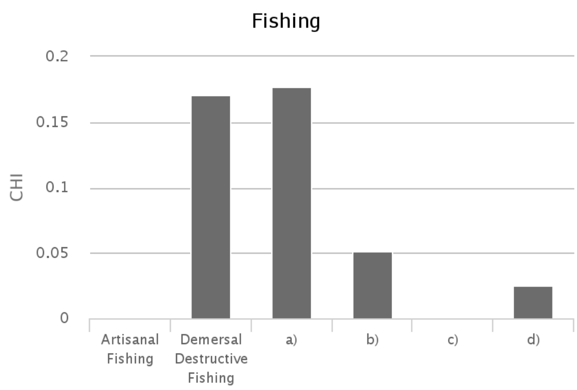
Mangrove and coral cover
Not applicable.

Reefs at risk
Not applicable.

Marine Protected Area change
The Barents Sea LME experienced an increase in MPA coverage from 70,379 km^2 prior to 1983 to 199,982 km^2 by 2014. This represents an increase of 184%, within the low category of MPA change.

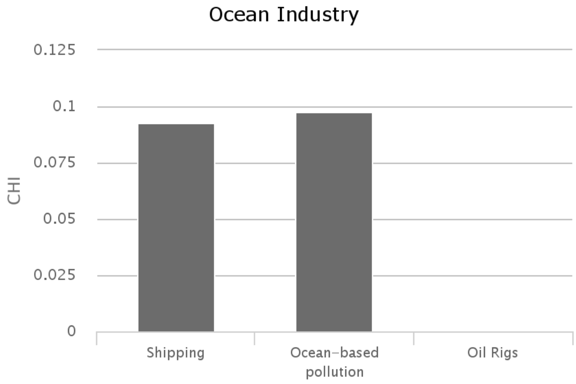
Cumulative Human Impact
The Barents Sea LME experiences an above average overall cumulative human impact (score 4.03; maximum LME score 5.22), which is also well above the LME with the least cumulative impact. It falls in risk category 4 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.83; maximum in other LMEs was 1.20), UV radiation (0.45; maximum in other LMEs was 0.76), and sea surface temperature (1.15; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, ocean based pollution, and all three types of demersal commercial fishing (demersal destructive, non-destructive low-bycatch, and non-destructive high-bycatch)..

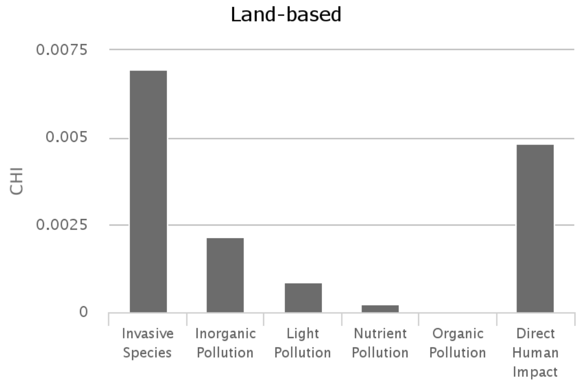


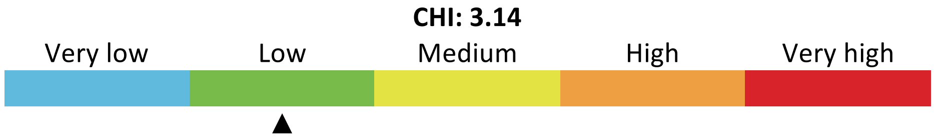


a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing

b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

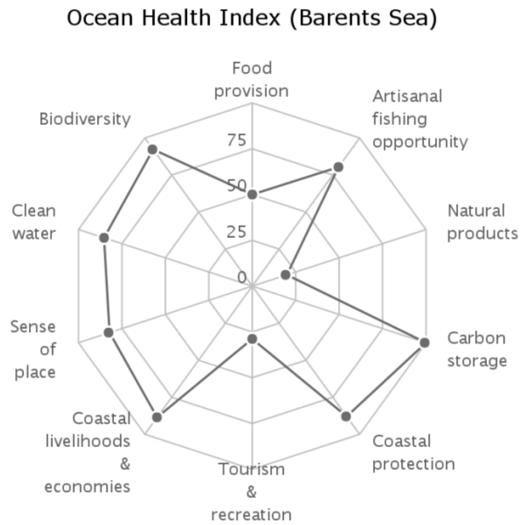


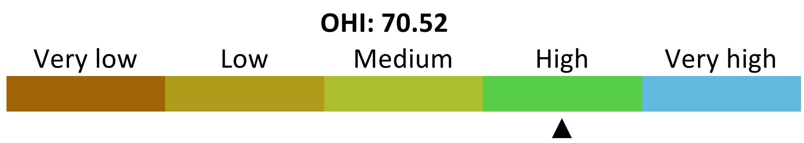




Ocean Health Index

The Barents Sea LME scores above average on the Ocean Health Index compared to other LMEs (score 74 out of 100; range for other LMEs was 57 to 82) but still relatively low. This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 remained unchanged compared to the previous year. This LME scores lowest on food provision, natural products and tourism & recreation goals and highest on artisanal fishing opportunities, carbon storage, coastal economies, lasting special places, and habitat biodiversity goals. It falls in risk category 2 of the five risk categories, which is a moderate level of risk (1 = lowest risk; 5 = highest risk).





Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for the Barents Sea LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area includes northern Norway, the shores of Murmansk, the Republic of Karelia, Arkhangelsk, the Nenets Autonomous Okrug, and the Norwegian island of Svalbard, all stretching over 743,645 km^2. A current population of 2 million in 2010 is projected to decrease to 1 M in 2100, with density decreasing from 3 persons per km^2 in 2010 to 2 per km^2 by 2100. About 33% of coastal population lives in rural areas, and is projected to decrease in share to 28% in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
2,028,968	1,101,642	675,670	307,031

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 11% of the LME's coastal dwellers. The Barents Sea places in the very low-risk category based on percentage and in the low risk category using absolute number of coastal poor (present day estimate).

Coastal poor
228,975

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. The Barents Sea LME ranks in the medium revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $556 million for the period 2001-2010. Fish protein accounts for 16% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013 $18,289 million places it in the medium revenue category. On average, LME-based tourism income contributes 6% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for the Barents Sea LME falls in the category with high risk (low/ modestly developed)..

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
556,441,114	15.9	18,288,744,573	6.4	0.8484

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day Barents Sea LME HDI belongs to the highest HDI and lowest risk category. Based on an HDI of 0.819, this LME has an HDI Gap of 0.181, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). The Barents Sea LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in high-risk category (low HDI) because of reduced income level compared to estimated income values in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.8194	0.9143	0.6366

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas, excluding fisheries).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index to the Barents Sea LME is within the medium-risk (medium threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is medium. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to low risk under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
0.6193	0.3403	0.3136	0.5083

Legend: Very low, Low, Medium, High, Very high

Governance

Governance architecture

In this LME, none of the transboundary fisheries arrangements appear to be integrated while the three arrangements for pollution and biodiversity appear to have the Arctic Council as an integrating arrangement for one set of issues and the OSPAR Convention for a second set of similar issues relating to pollution and biodiversity. Additionally, the specific biodiversity arrangements for marine mammals and polar bears do not appear to have any formal linkages. Whereas, the Arctic Council is

not a binding arrangement, so its implementation is voluntary and country dependent, it does appear to have the potential to develop into an informal overall policy coordinating organization. Nonetheless, this LME has been assigned an overall integration score of 1.0 due to the presence of the Arctic Council with its ability to potentially function as an overall policy coordinating organization for the key transboundary issues within the LME.
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
75	74	0.1

Legend: Very low, Low, Medium, High, Very high

LME 50 – Sea of Japan

Bordering countries: Japan, Korea, Democratic Republic of Korea.
LME Total area: 1,054,305 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit low to medium levels of economic development (based on the night light development index) and medium levels of collapsed and overexploited fish stocks.

Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is medium.

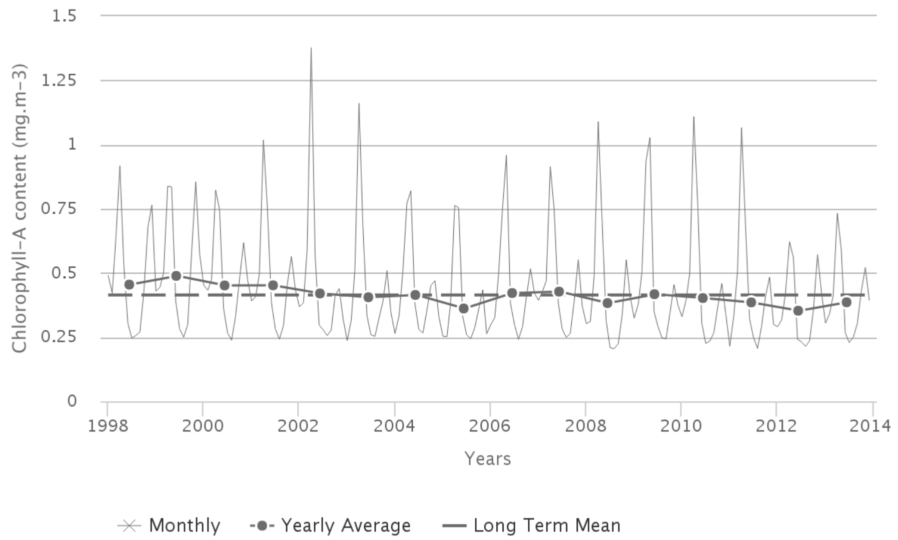
Very low | Low | Medium | High | Very high

Productivity

Chlorophyll-A

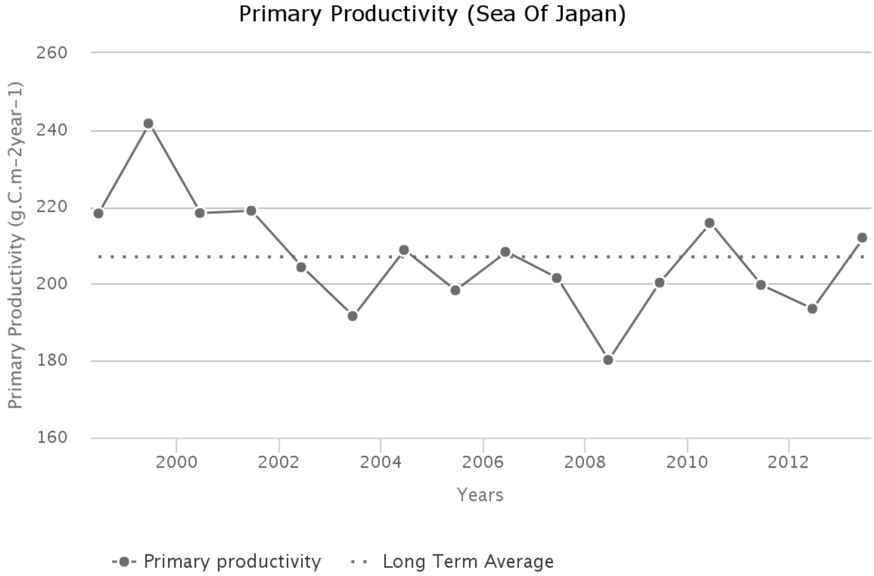
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.905 mg.m-3) in April and a minimum (0.242 mg.m-3) during August. The average CHL is 0.414 mg.m-3. Maximum primary productivity (242 g.C.m-2.y-1) occurred during 1999 and minimum primary productivity (180 g.C.m-2.y-1) during 2008. There is a statistically insignificant increasing trend in Chlorophyll of 6.79 % from 2003 through 2013. The average primary productivity is 207 g.C.m-2.y-1, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).

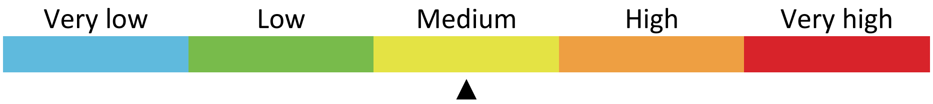
Chlorophyll-A (Sea Of Japan)



Very low | Low | Medium | High | Very high

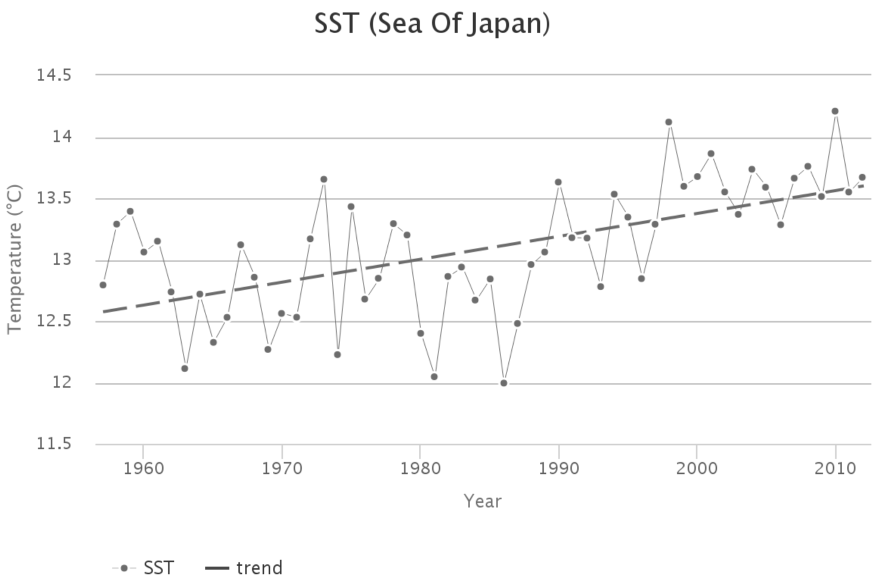
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Sea of Japan LME #50 has warmed by 1.05°C, thus belonging to Category 2 (fast warming LME). The Japan Sea–like the adjacent East China Sea–was not warming until the 1980s. Unlike the East China Sea, where abrupt warming began in 1982, the warming epoch in the Japan Sea commenced after 1986. Between 1986 and 2010, SST rose from 12.0°C to 14.1°C, an increase by 2.1°C in 23 years. The decadal variability of the Japan Sea is primarily influenced by the Siberian high, which is related to the Arctic Oscillation and North Atlantic Oscillation, and secondarily by the Aleutian low, whose decadal variability is linked to the Pacific Decadal Oscillation (Minobe et al., 2004). However, the North Pacific regime shift of 1976-1977 has not transpired in the Japan Sea SST time series.

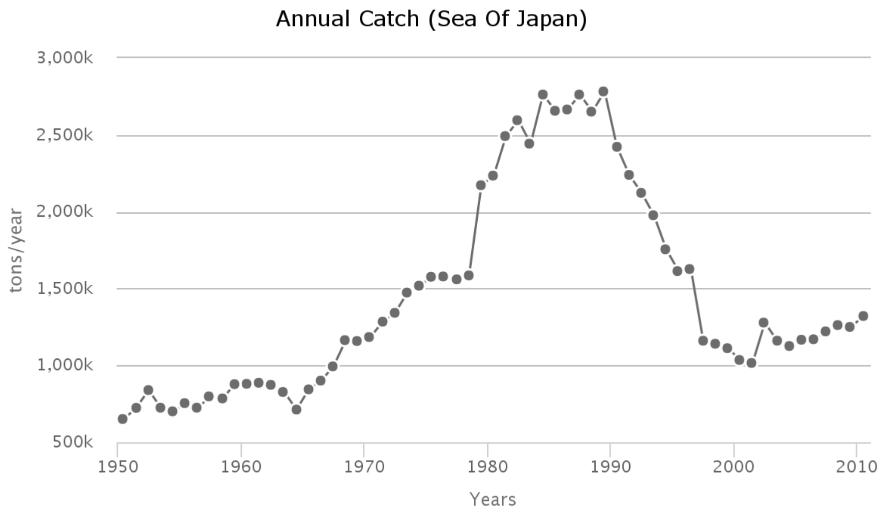


Fish and Fisheries

Marine fisheries are an important economic sector for the countries bordering the Sea of Japan LME. Both cold and warm-water fish occur in the LME, with salmon, Alaska pollock, sea urchin, sea cucumber, crab and shrimp being the most valuable species. Long-term fluctuations of Pacific sardine accompanied by noticeable geographic shifts in its spawning and nursery grounds have been observed, but no relationship has been found between high sardine catches and the Tsushima Current.

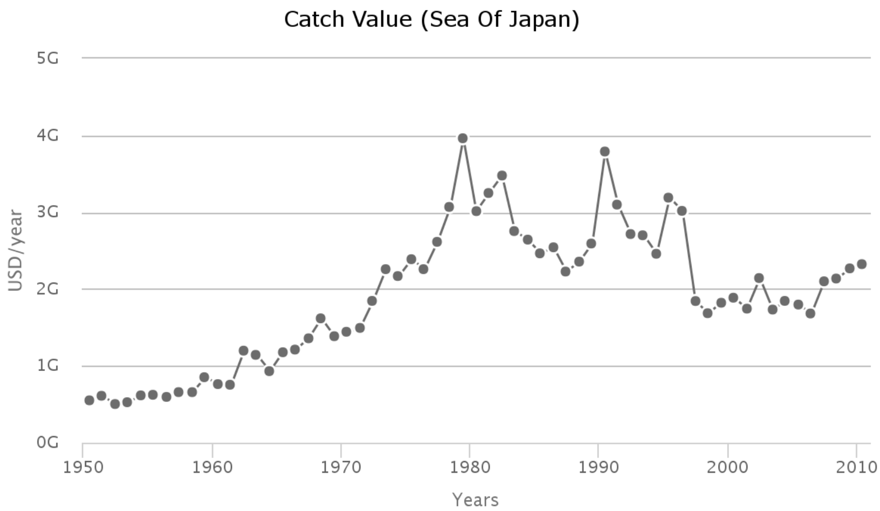
Annual Catch

Total reported landings in the LME reached 2.8 million t in 1989 but have since declined to around 1.2 million t in the recent 10 years. The fluctuation in the landings can be attributed mainly to the high reported landings of Pacific sardine, which accounted for 30% of the total landings in the mid to late 1980s.



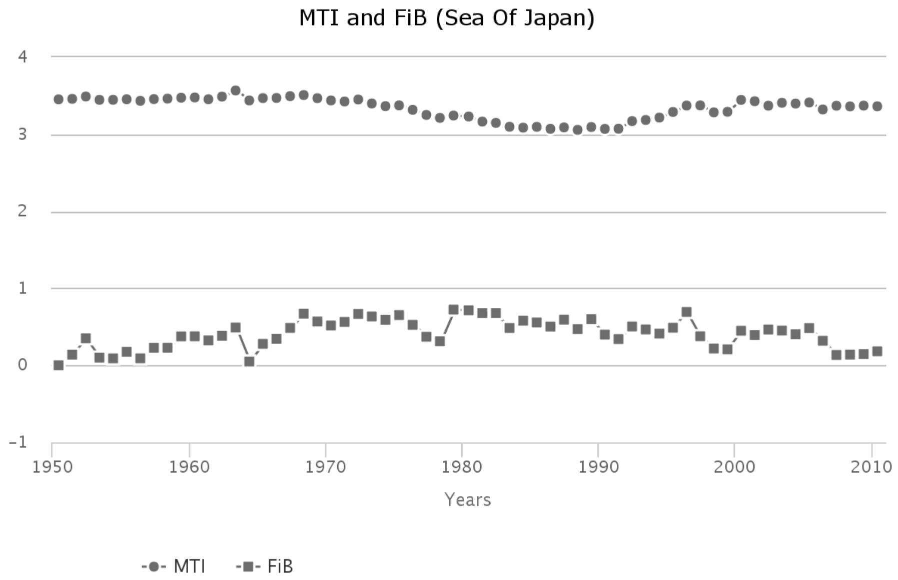
Catch value

The value of the reported landings also rose steadily to about 4 billion US$ (in 2005 real US$) in 1979.



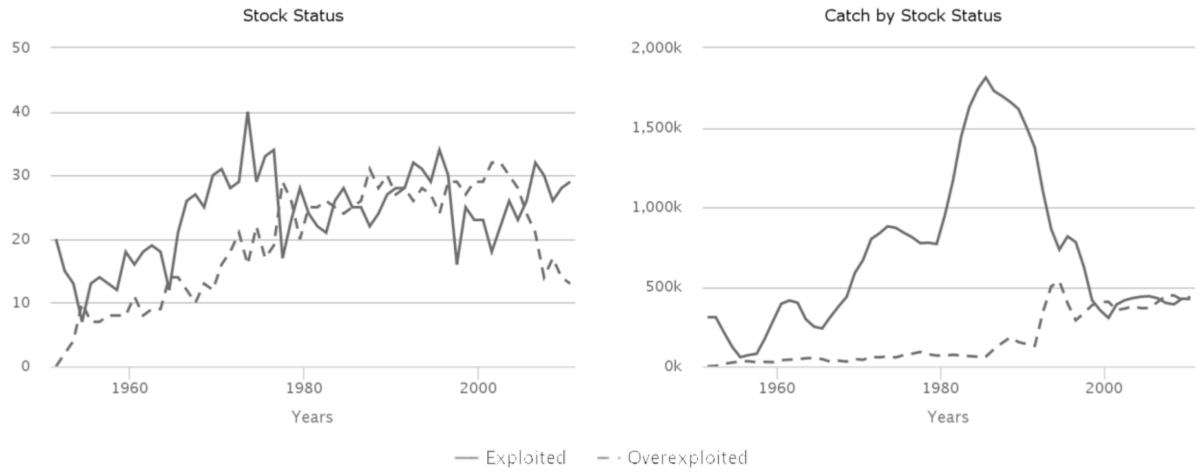
Marine Trophic Index and Fishing-in-Balance index

The MTI shows a large fluctuation, reflecting the cyclic nature in the relative abundance, and hence the landings, of the low-trophic Pacific sardine. The FiB index suggests a period of expansion in the 1950s and 1960s, after which the index levels off, indicating that the decrease in the mean trophic level resulting from the high proportion of reported landings of Pacific sardine in the 1980s was compensated for by its large volume of landings.



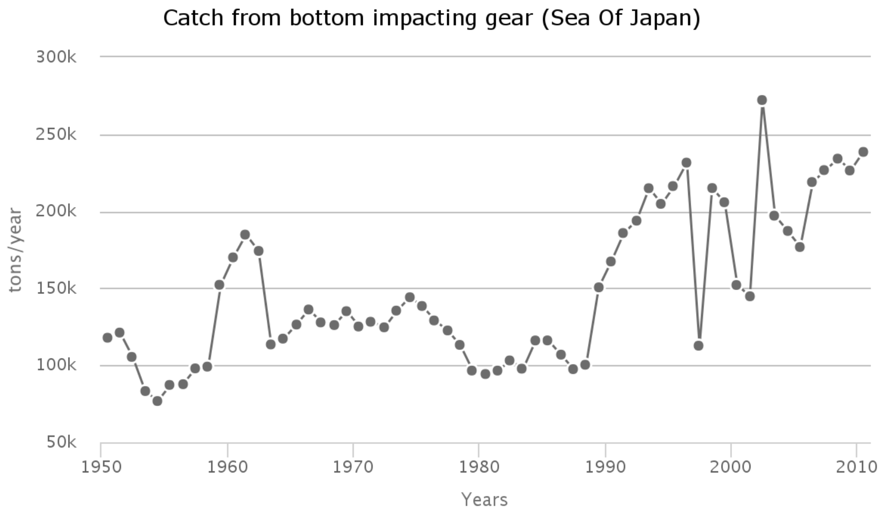
Stock status

The Stock-Catch Status Plots indicate that the number of collapsed and overexploited stocks in the LME has been rapidly increasing, to 30 % of the commercially exploited stocks, with about 40% of the reported landings still supplied by fully exploited stocks.



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch decreased from around 16% in the early 1950s to its lowest point at around 2% in 1987. Then, this percentage kept increasing and reached its peak at 19% in 2001. It fluctuated around 18% in recent decade.

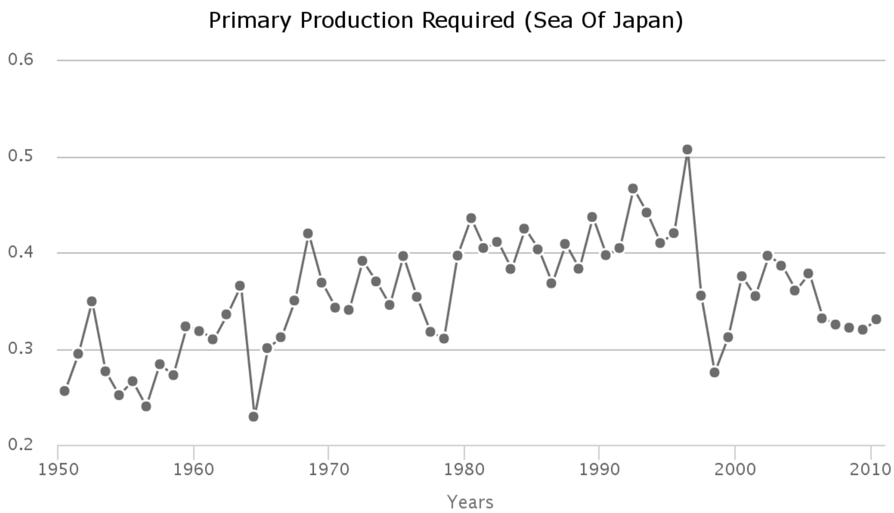


Fishing effort

The total effective effort continuously increased from around 24 million kW in the 1950s to its peak around 145 million kW in 2005.

Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME reached 50% of the observed primary production in the 1990s but has since declined in recent years.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.
An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was moderate (level 3 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
3	2	3	3	2	3	3	2	3

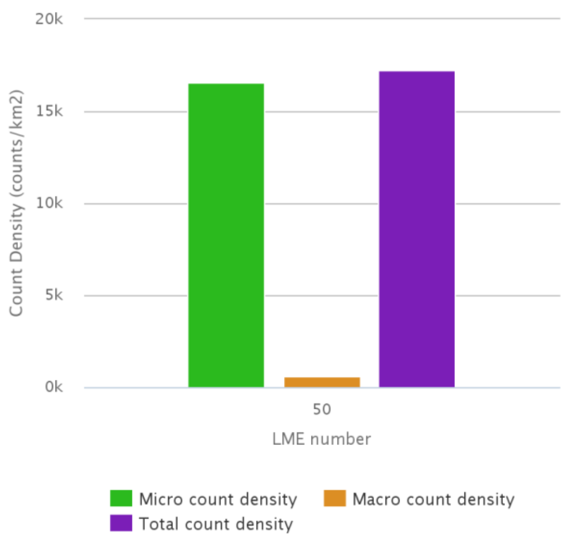
Legend:
Very low; Low; Medium; High; Very high

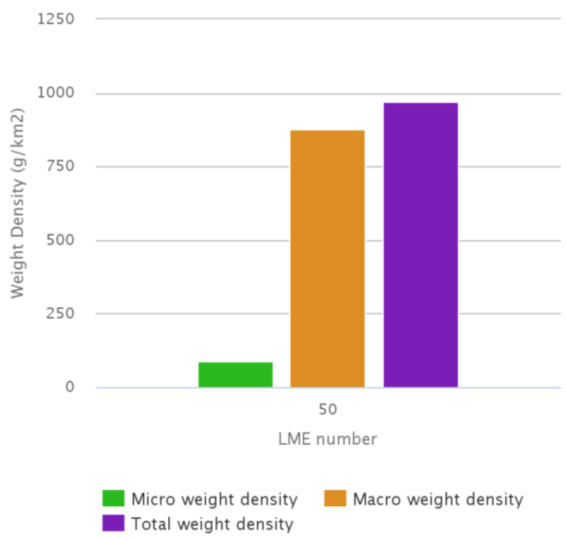
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively high levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to the relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 100 times higher that those LMEs with lowest values. There is moderate evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

Not applicable.

Reefs at risk

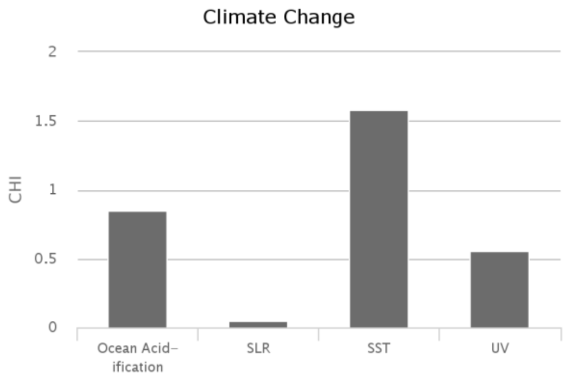
Not applicable.

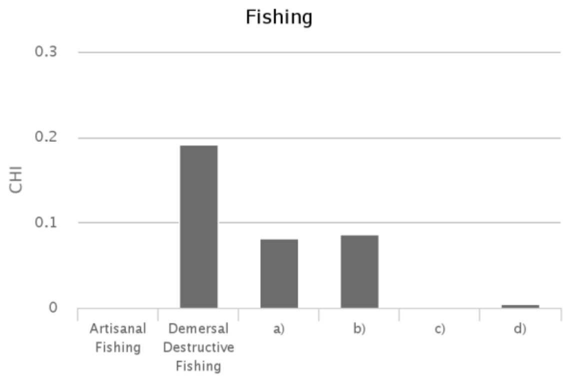
Marine Protected Area change

The Sea of Japan LME experienced an increase in MPA coverage from 4,065 km^2 prior to 1983 to 5,721 km^2 by 2014. This represents an increase of 40%, within the lowest category of MPA change.

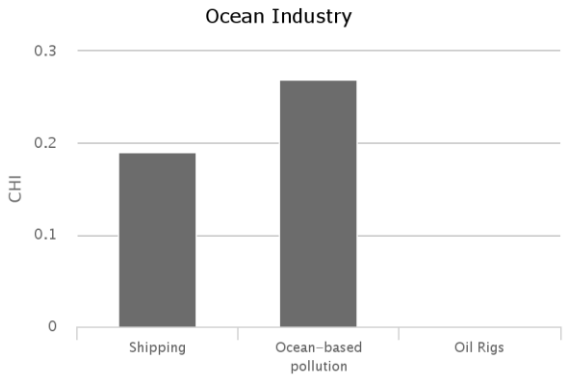
Cumulative Human Impact

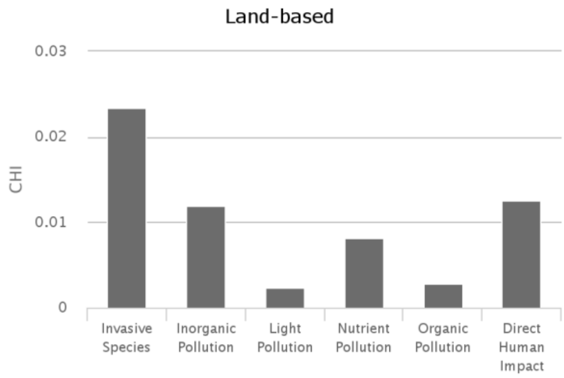
The Sea of Japan LME experiences above average overall cumulative human impact (score 3.91; maximum LME score 5.22), which is also well above the LME with the least cumulative impact. It falls in risk category 4 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.85; maximum in other LMEs was 1.20), UV radiation (0.55; maximum in other LMEs was 0.76), and sea surface temperature (1.58; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, sea level rise, ocean based pollution, and all three types of demersal commercial fishing (demersal destructive, non-destructive low-bycatch, and non-destructive high-bycatch).

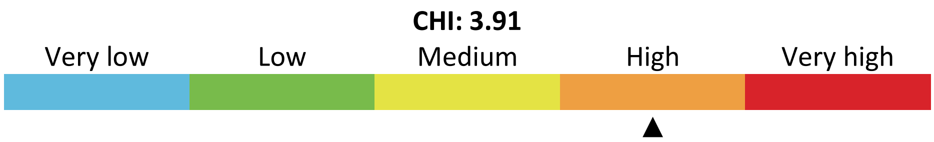




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

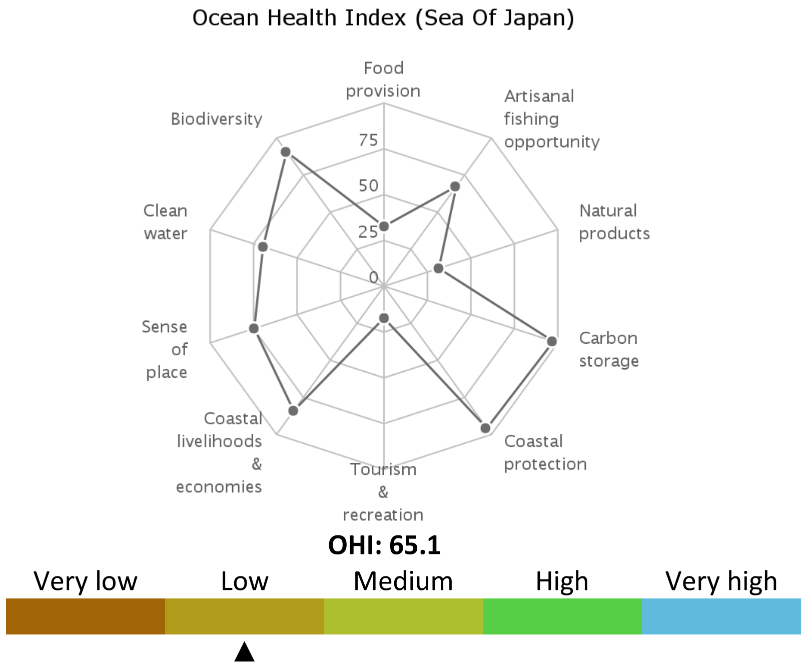






Ocean Health Index

The Sea of Japan LME scores below average on the Ocean Health Index compared to other LMEs (score 68 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 remained unchange compared to the previous year. This LME scores lowest on food provision, natural products and tourism & recreation goals and highest on artisanal fishing opportunities, coastal protection, carbon storage, coastal economies, and habitat biodiversity goals. It falls in risk category 4 of the five risk categories, which is a relatively high level of risk (1 = lowest risk; 5 = highest risk).



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 511,094 km^2. A current population of 73 157 thousand in 2010 is projected to decrease to 55 696 thousand in 2100, with a density of 143 persons per km^2 in 2010 decreasing to 109 per km^2 by 2100. About 28% of coastal population lives in rural areas, and is projected to slightly decrease in share to 27% in 2100.

Total population		Rural population	
2010	2100	2010	2100
73,156,955	55,696,060	20,687,130	14,794,886

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 14% of the LME's coastal dwellers. This LME places in the low-risk category based on percentage and in the high-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
10,135,039

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very high-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $2 353 million for the period 2001-2010. Fish protein accounts for 37% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$80 112 million places it in the high-revenue category. On average, LME-based tourism income contributes 7% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with medium risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
2,353,242,447	36.9	80,112,423,060	6.6	0.7218

Legend: Very low | Low | Medium | High | Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.882, this LME has an HDI Gap of 0.118, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a high-risk category (low HDI) because of reduced income levels and population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.8823	0.8938	0.6718

Legend: Very low | Low | Medium | High | Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the medium-risk (medium threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is high. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to medium under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
0.6036	0.3506	0.3908	0.5563

Legend:

Very low Low Medium High Very high

Governance

Governance architecture

In this LME, there is essentially no transboundary fisheries arrangement. However, PICES does provide opportunity for transboundary cooperation in assessment in science. The fact that there is no Regional Seas convention covering the area, only an action plan seriously weakens capacity for transboundary governance in areas relating to biodiversity and pollution. There is the potential for integration of pollution and biodiversity issues under NOWPAP should it proceed to the level of a Convention. There does not appear to be any organisation other than NOWPAP that could integrate and coordinate across the full range of issues required for EBM.

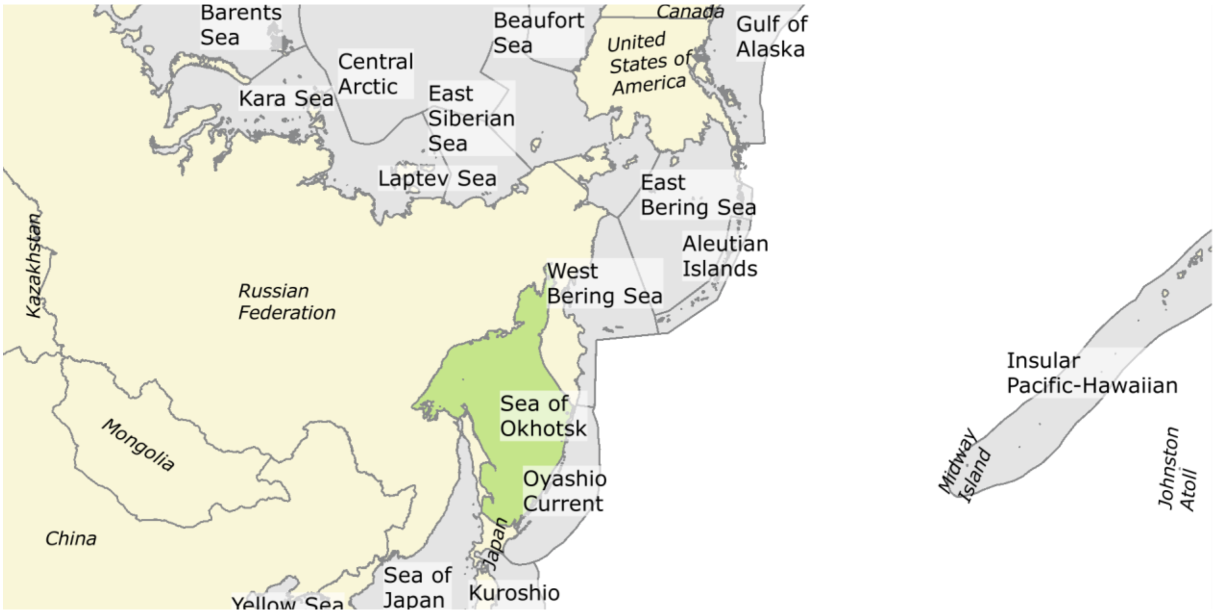
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
88	30	0.5

Legend:

Very low Low Medium High Very high

LME 52 – Sea of Okhotsk



Bordering countries: Japan, Russian Federation.
LME Total area: 1,627,284 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit low to medium levels of economic development (based on the night light development index) and medium levels of collapsed and overexploited fish stocks.

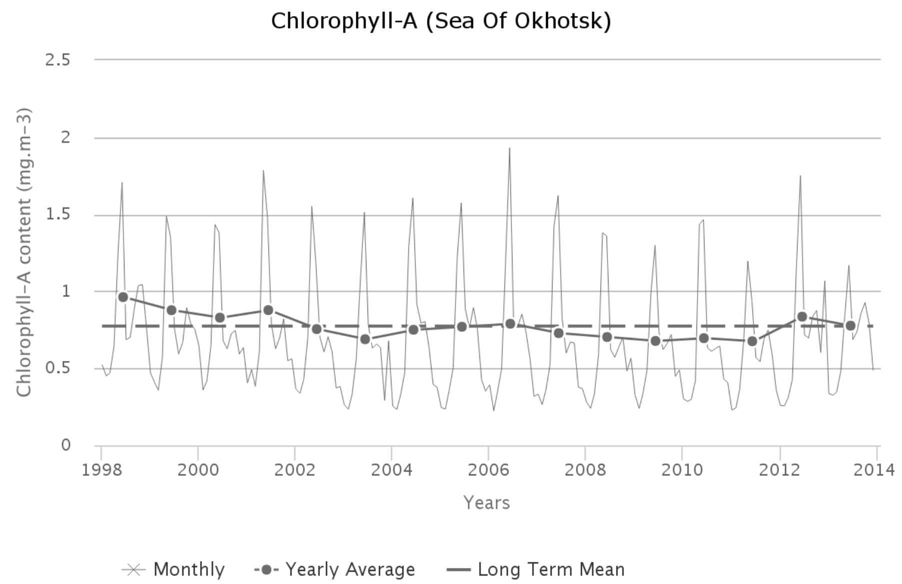
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is medium.

Very low | Low | Medium | High | Very high

Productivity

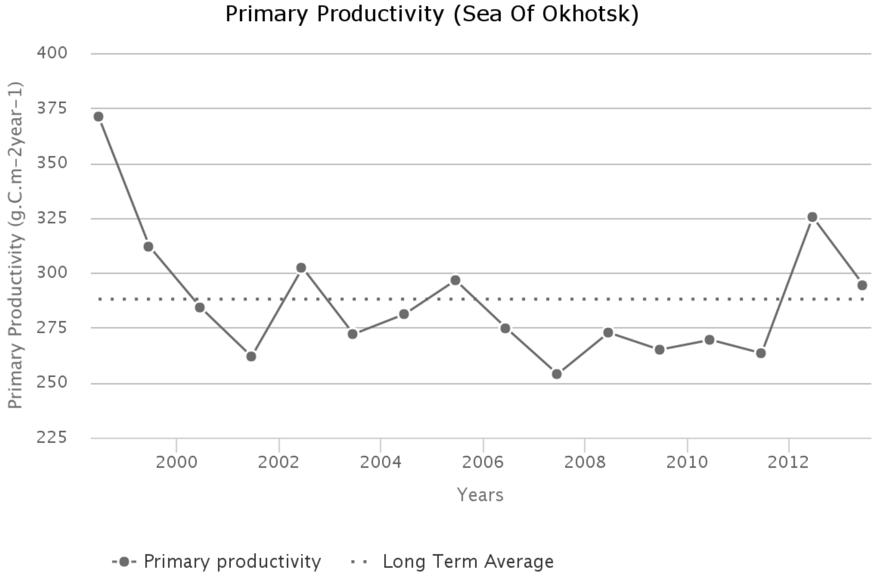
Chlorophyll-A

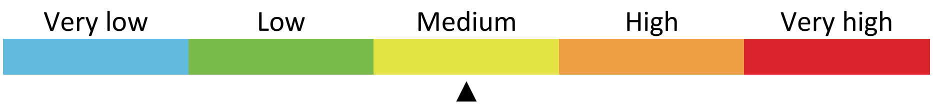
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (1.42 mg.m^{-3}) in June and a minimum (0.261 mg.m^{-3}) during February. The average CHL is 0.774 mg.m^{-3}. Maximum primary productivity (371 g.C.m^{-2}.y^{-1}) occurred during 1998 and minimum primary productivity (254 g.C.m^{-2}.y^{-1}) during 2007. There is a statistically insignificant increasing trend in Chlorophyll of 4.95 % from 2003 through 2013. The average primary productivity is 288 g.C.m^{-2}.y^{-1}, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).



Very low | Low | Medium | High | Very high

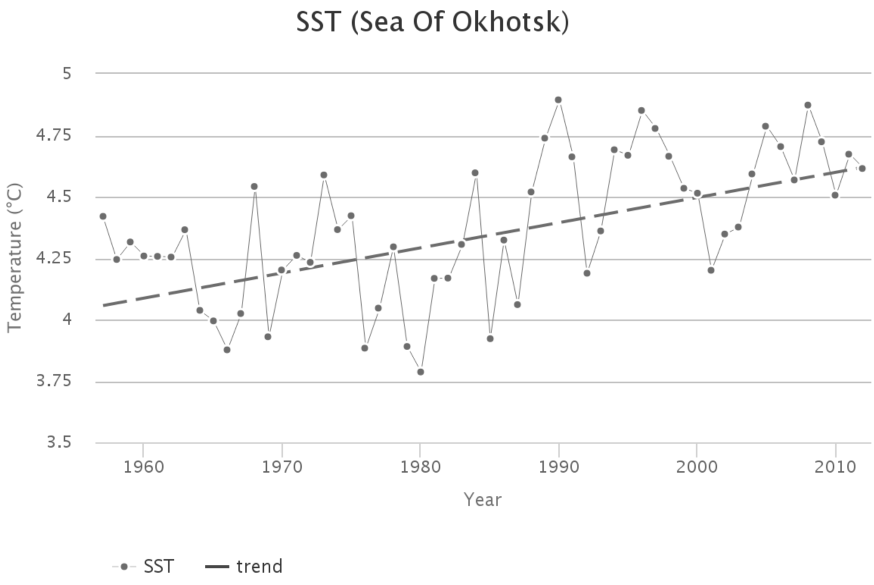
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Okhotsk Sea LME #52 has warmed by 0.57°C, thus belonging to Category 3 (moderate warming LME). The thermal history of the Okhotsk Sea is linked to that of the Oyashio Current LME #51. In both LMEs, a major regime shift occurred in the late 1980s (Mantua et al., 1997; Hare and Mantua, 2000). The last cold year was 1987 (cf. 1988 in the Oyashio). During the preceding cold epoch, SST reached the all-time minimum of 3.8°C in 1980. The all-time maximum of 4.9°C in 1990 was synchronous with the all-time SST maximum in the Oyashio Current LME #51. During the warm epoch (after the regime shift of 1987-1988), both cold events, of 1992 and 2001, occurred approximately one year before similar cold events of 1992-93 and 2002-03 in the Oyashio Current LME #51. The one-year time lag between similar events in the Okhotsk Sea and Oyashio Current suggests an impact of the Okhotsk Sea on the Oyashio Current. The pan-Pacific regime shift of 1976-1977 has not transpired in the Okhotsk Sea SST.

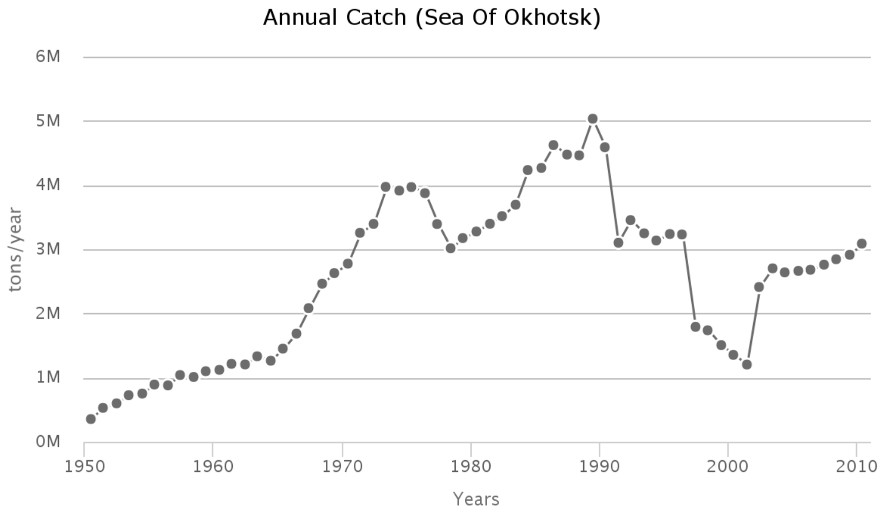


Fish and Fisheries

The Sea of Okhotsk LME is rich in fisheries resources. Within the Russian EEZ, the fish stocks have been estimated at 26 million t including 16 million t of gadoids.

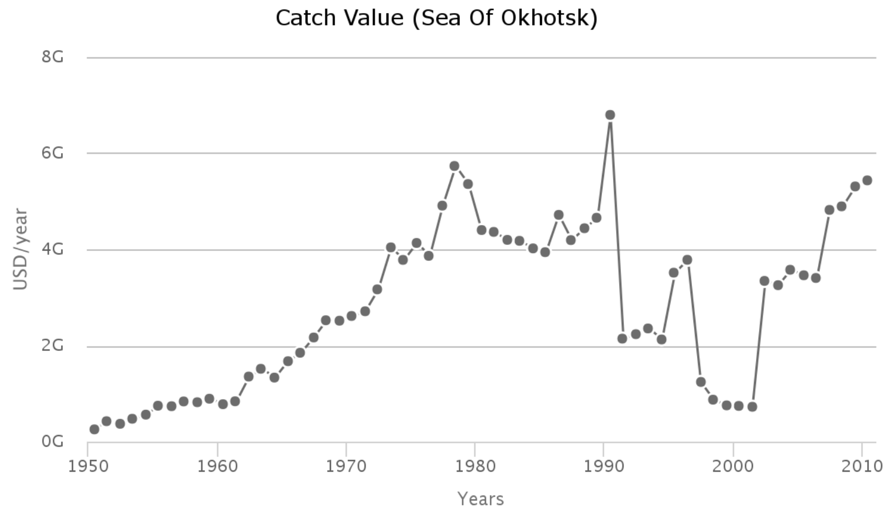
Annual Catch

Total reported landings showed a peak with 5 million t in 1989. The majority of the landings consist of Alaska pollock, which accounted for almost two-thirds of the total landings in the mid-1980s.



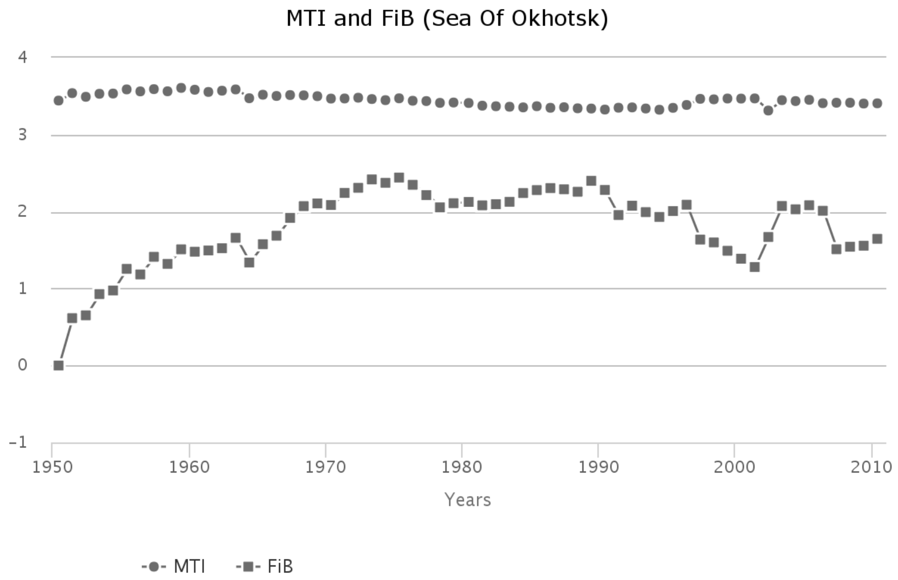
Catch value

The reported landings were valued around 6.8 billion US$ (in 2005) during the peak landings of the late 1980s.



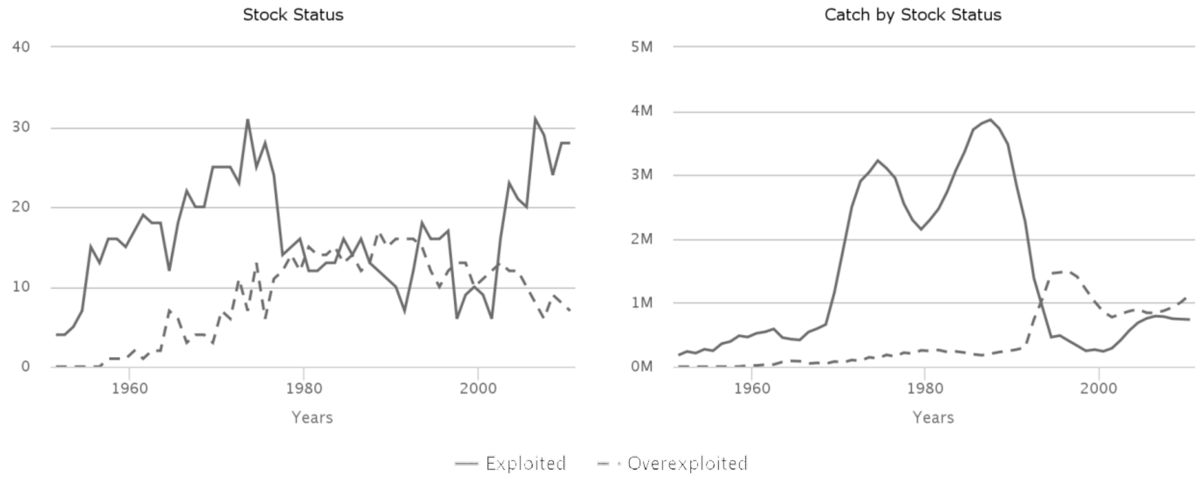
Marine Trophic Index and Fishing-in-Balance index

The MTI underwent a steady decline to early 1990s, suggesting a 'fishing down' of the local food webs, despite the expansion of fisheries in the region over the same period as evident by the increase in the FiB index, which leveled off in the early 1990s. As the landings in the LME became dominated by Alaska pollock, a high-trophic level species, the mean trophic level began to increase despite the decline in the total landings.



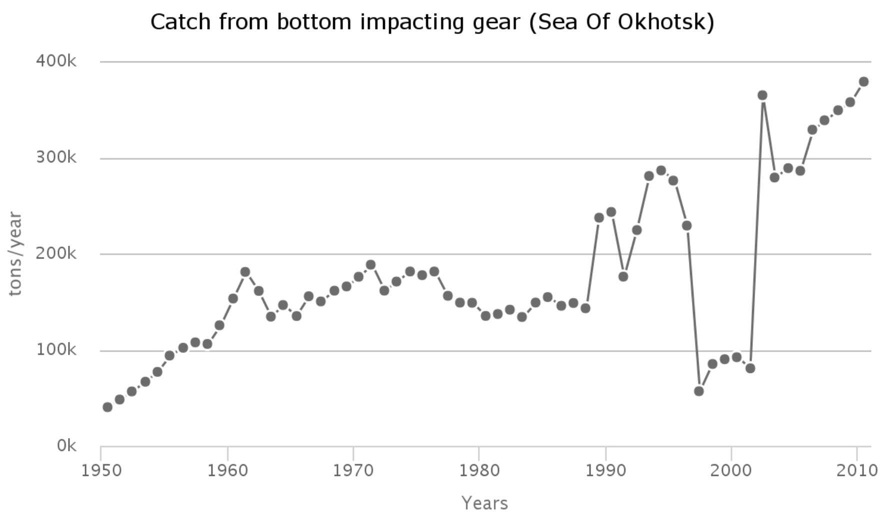
Stock status

The Stock-Catch Status Plots indicate that the number of collapsed and overexploited stocks in the LME have been increasing to about 30 % of the commercially exploited stocks, which account for about 50% of the catch.



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch reached its first peak at 15% in 1960 and then decreased to around 3% in 1987. Then, the percentage fluctuated around 12% in recent decade.

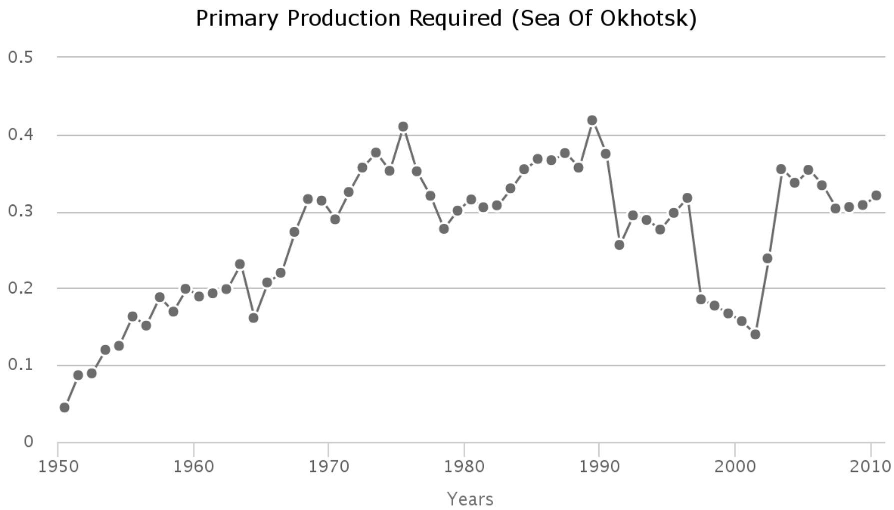


Fishing effort

The total effective effort continuously increased from around 14 million kW in the 1950s to its peak around 55 million kW in 2005.

Primary Production Required

The primary production required (PPR) to sustain the reported landings in the LME reached 50% of the observed primary production in the mid-1980s, but has declined in recent years.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.

An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was low (level 2 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this increased to moderate in 2030 and remained moderate in 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this increased to moderate in 2030 and remained the same in 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
2	2	2	3	2	3	3	2	3

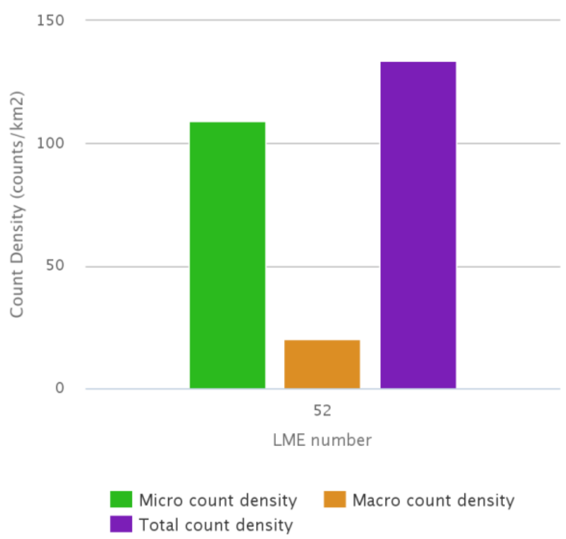
Legend: Very low, Low, Medium, High, Very high

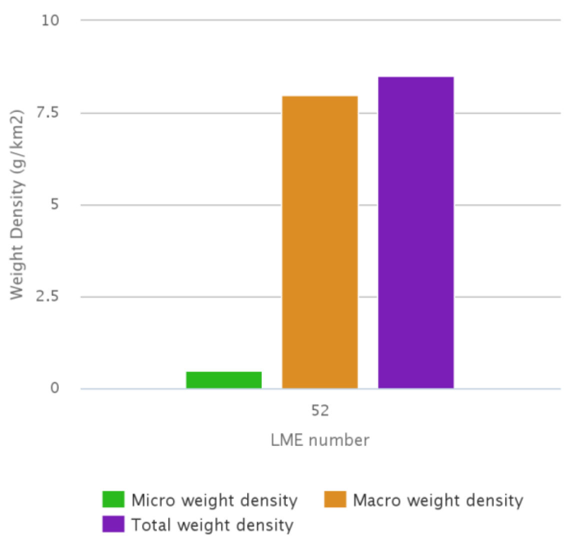
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the lowest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The low values are due to the remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be over 400 times lower than those LMEs with the highest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

Not applicable.

Reefs at risk

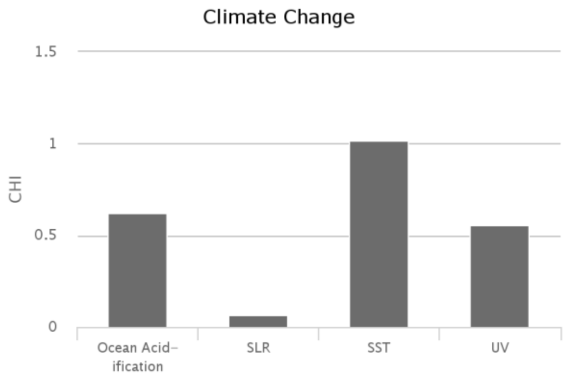
Not applicable.

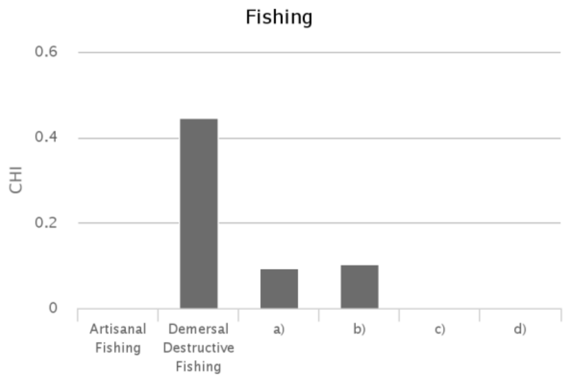
Marine Protected Area change

The Sea of Okhotsk LME experienced an increase in MPA coverage from 891 km^2 prior to 1983 to 1,504 km^2 by 2014. This represents an increase of 83%, within the lowest category of MPA change.

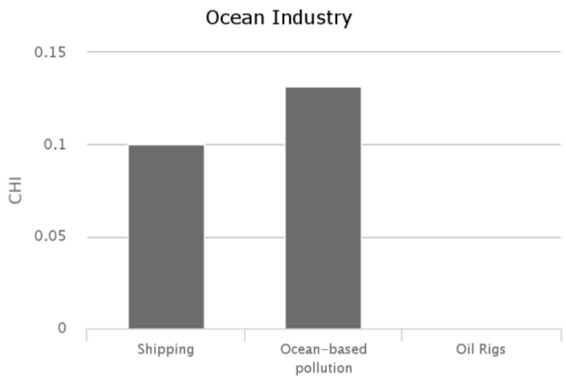
Cumulative Human Impact

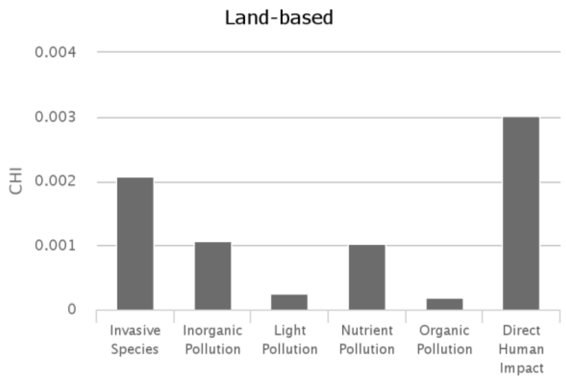
The Sea of Okhotsk LME experiences below average overall cumulative human impact (score 3.15; maximum LME score 5.22), but which is still well above the LME with the least cumulative impact. It falls in risk category 2 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.62; maximum in other LMEs was 1.20), UV radiation (0.56; maximum in other LMEs was 0.76), and sea surface temperature (1.02; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, sea level rise, ocean based pollution, and all three types of demersal commercial fishing (demersal destructive, non-destructive low-bycatch, and non-destructive high-bycatch).

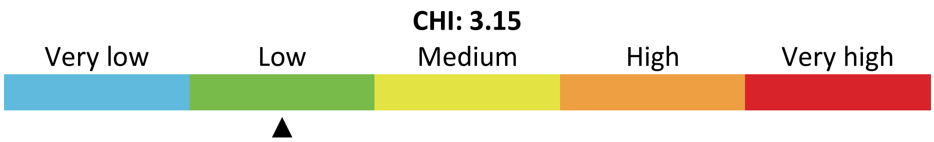




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

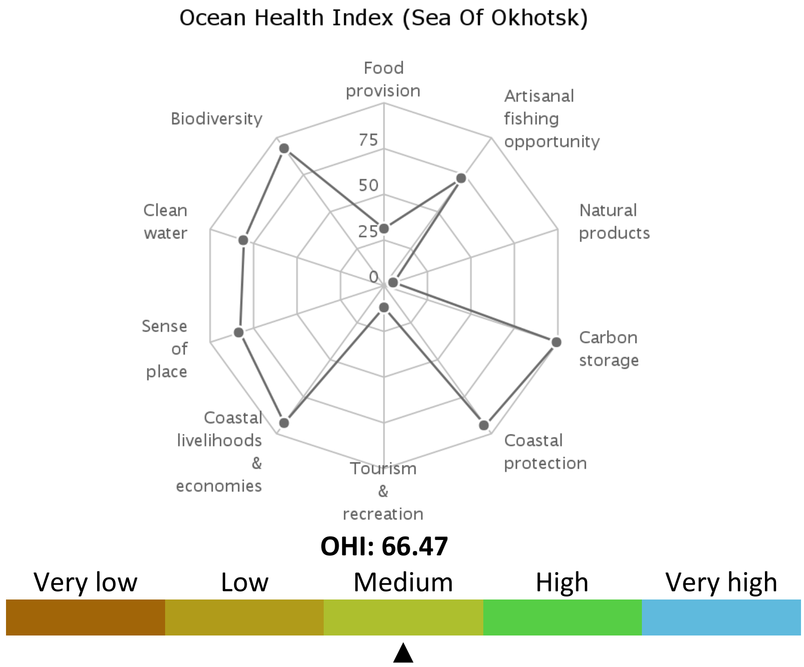






Ocean Health Index

The Sea of Okhotsk LME scores below average on the Ocean Health Index compared to other LMEs (score 68 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 decreased 1 point compared to the previous year, due in large part to changes in the score for clean waters. This LME scores lowest on food provision, natural products, and tourism & recreation goals and highest on artisanal fishing opportunities, coastal protection, carbon storage, coastal economies, lasting special places and habitat biodiversity goals. It falls in risk category 4 of the five risk categories, which is a relatively high level of risk (1 = lowest risk; 5 = highest risk).



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 585 278 km^2. A current population of 1 624 thousand in 2010 is projected to decrease to 681 thousand in 2100, with a density of 3 persons per km^2 in 2010 decreasing to 1 per km^2 by 2100. About 55% of coastal population lives in rural areas, and is projected to maintain this share in 2100.

Total population		Rural population	
2010	2100	2010	2100
1,624,225	681,092	886,897	372,409

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 14% of the LME's coastal dwellers. This LME places in the medium-risk category based on percentage and in the low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
233,122

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very high-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $4 549 million for the period 2001-2010. Fish protein accounts for 27% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$15 231 million places it in the medium-revenue category. On average, LME-based tourism income contributes 7% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with medium risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
4,548,752,505	27.1	15,230,970,720	6.6	0.7612

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.842, this LME has an HDI Gap of 0.158, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a medium-risk category (medium HDI) because of reduced income levels and population values from those in a sustainable development pathway.

HDI	HDI 2100	
	SSP1	SSP3
0.8418	0.9532	0.7003

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (*e.g.* overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the medium-risk (medium threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is high. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to low under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
0.6175	0.3430	0.2694	0.4962

Legend:

Very low · Low · Medium · High · Very high

Governance

Governance architecture

The fact that there is no regional seas convention covering this LME, only an action plan (NOWPAP), seriously weakens capacity for transboundary governance in areas relating to pollution and biodiversity. There is no indication of transboundary integration, other than through cooperation in science. There is the potential for integration of pollution issues under NOWPAP should it proceed to the level of a Convention. There does not appear to be any other transboundary organisation than NOWPAP that could integrate and coordinate across the full range of issues required for EBM.

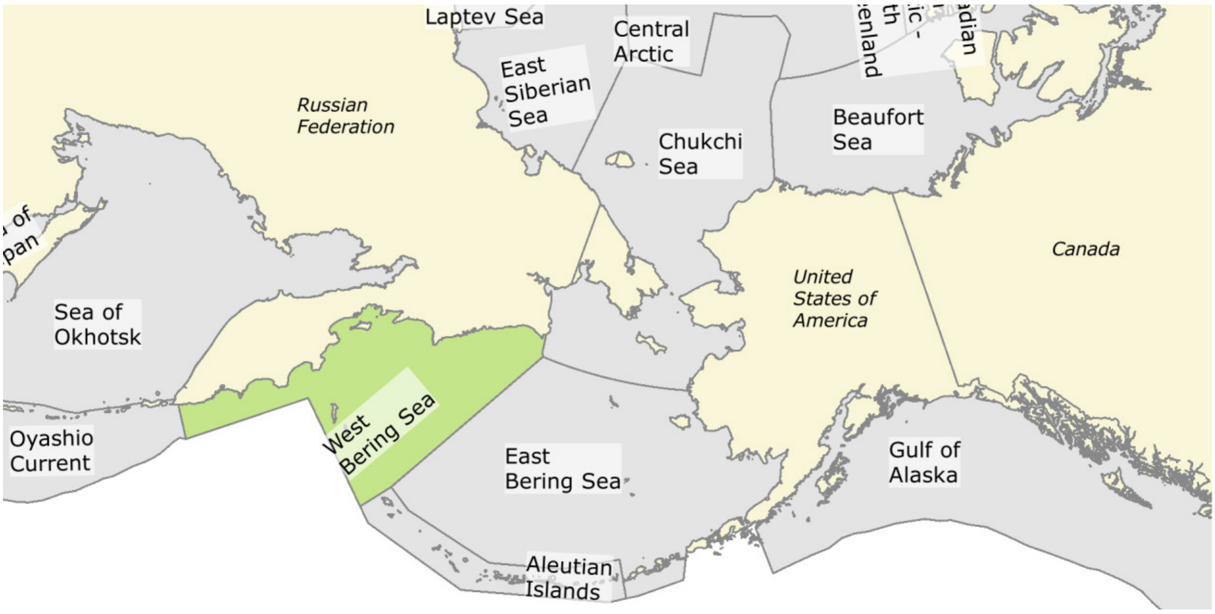
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
100	**38**	**0.9**

Legend:

Very low · Low · Medium · High · Very high

LME 53 – West Bering Sea



Bordering countries: Russian Federation, United States of America.
LME Total area: 2,182,768 km^2

List of indicators

LME overall risk

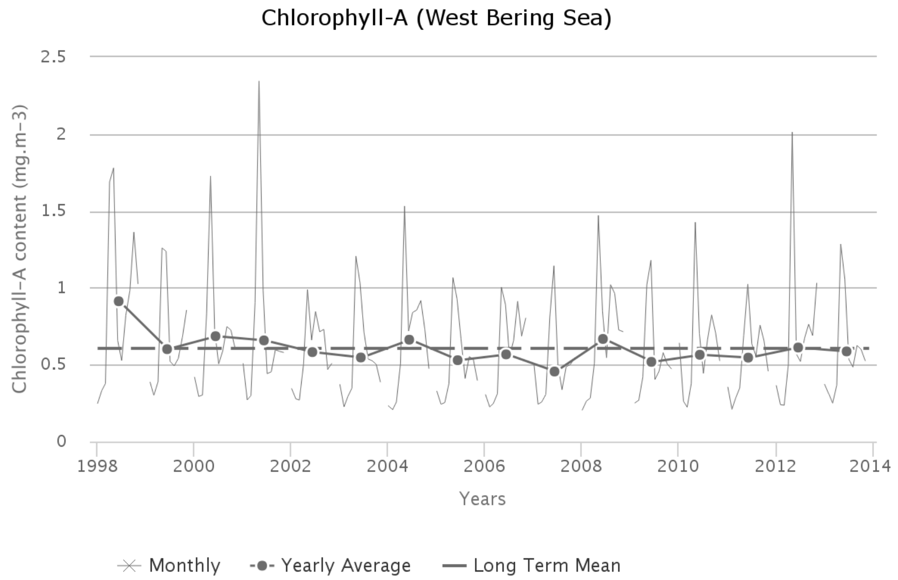
This LME falls in the cluster of LMEs that exhibit low to medium levels of economic development (based on the night light development index) and medium levels of collapsed and overexploited fish stocks.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is medium.

Very low Low Medium High Very high

Productivity

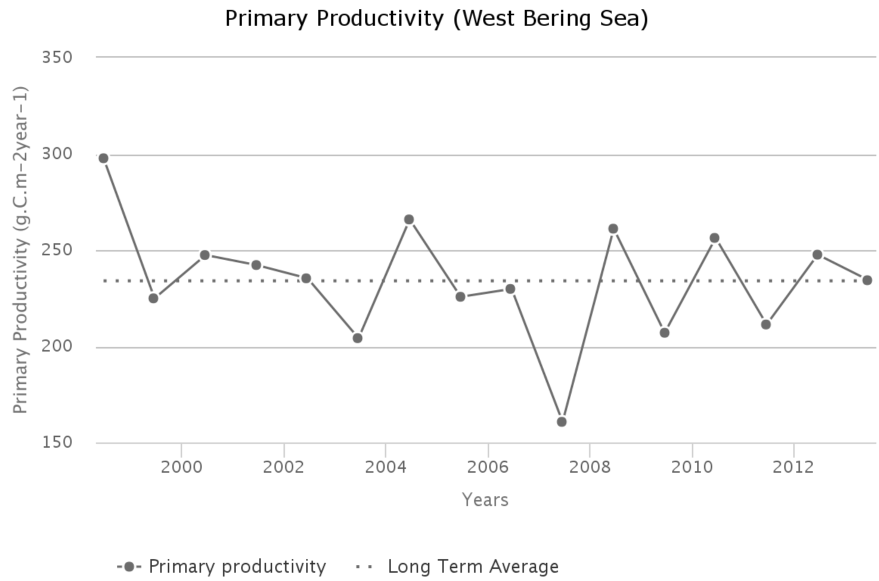
Chlorophyll-A

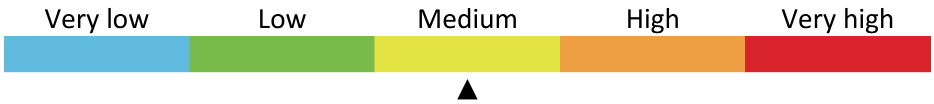
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (1.22 $mg.m^{-3}$) in May and a minimum (0.250 $mg.m^{-3}$) during February. The average CHL is 0.606 $mg.m^{-3}$. Maximum primary productivity (298 $g.C.m^{-2}.y^{-1}$) occurred during 1998 and minimum primary productivity (161 $g.C.m^{-2}.y^{-1}$) during 2007. There is a statistically insignificant increasing trend in Chlorophyll of 14.1 % from 2003 through 2013. The average primary productivity is 234 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).



Very low Low Medium High Very high

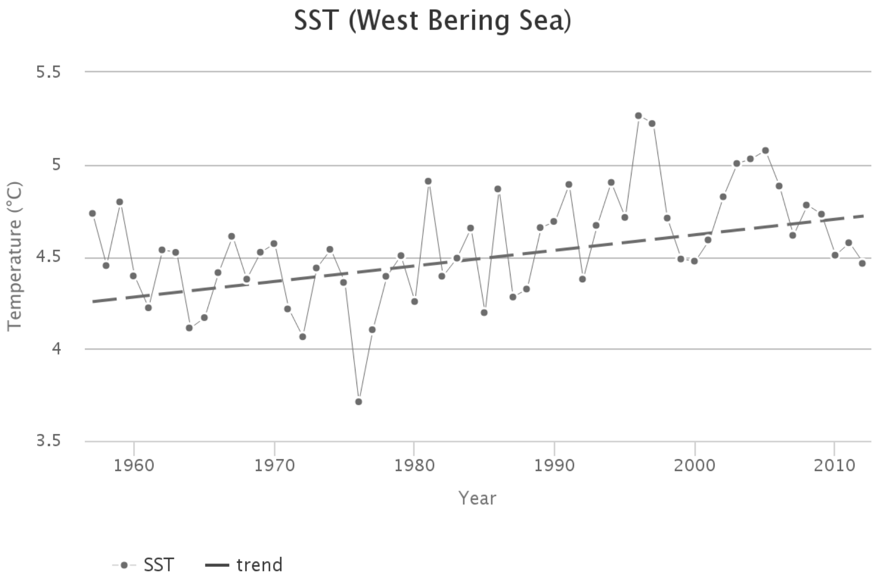
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the West Bering Sea LME #53 has warmed by 0.47°C, thus belonging to Category 3 (moderate warming LME). The long-term cooling of the late 1950s-early 1970s culminated in the all-time minimum of 3.7°C in 1976. The North Pacific regime shift of 1976-77 (Mantua et al., 1997; Hare and Mantua, 2000) has transpired in the West Bering Sea with the utmost clarity and was extremely abrupt. It manifested as a rapid 0.6°C SST rise between 1976 and 1978. This rise was followed by a steady SST increase until present. Thus, the regime shift of 1976-77 was a switch from a long-term cooling to a long-term warming, separated by a step-like SST increase. The all-time maximum of >5.2°C in1996 is bizarre since it occurred before the El Niño 1997-98 and before a similar warm event in the East Bering Sea. The cold event of 1999 occurred simultaneously across the entire Bering Sea.

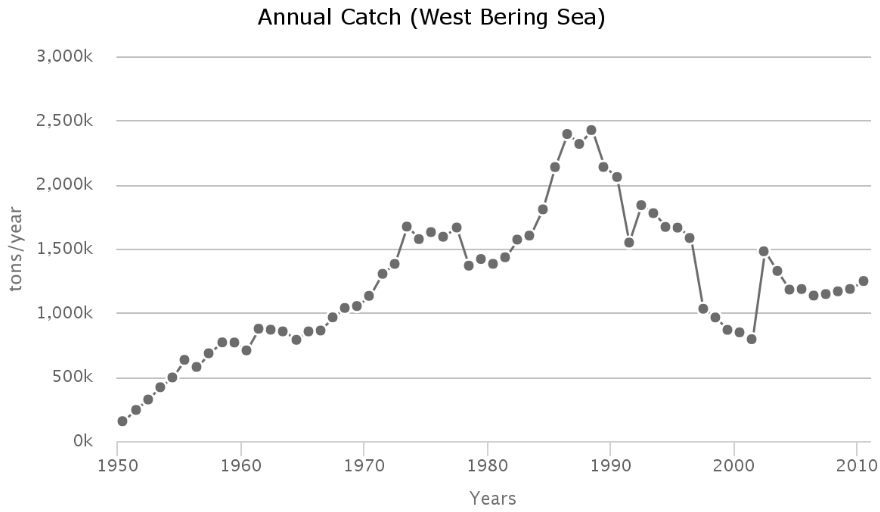


Fish and Fisheries

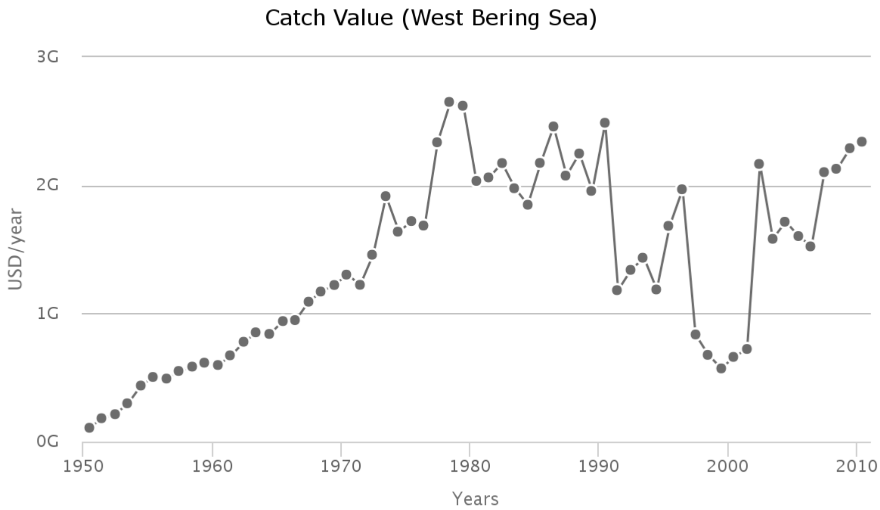
The West Bering Sea LME has the largest biomass of cod-like fishes in the world. Other species fished include Alaskan pollock, Pacific saury, salmon, flatfish, rockfish, halibut, flounder, herring, squid and a variety of crab species and other crustaceans. A major problem is unreported fishing in the West Bering Sea and in the 'Donut Hole', a high seas area that does not come under the jurisdiction of either Russia or the USA (Alaska). Catches have been illegally transferred to Russian carrier vessels bound for ports in Japan, South Korea, China, the U.S.A. and Canada. There is evidence of fishing in prohibited areas. The rise of industrial fishing has also had a major impact.

Annual Catch

Total reported landings recorded 2.4 million t in 1988 but have since declined by about half, with only 1.2 million t reported in the most recent year.

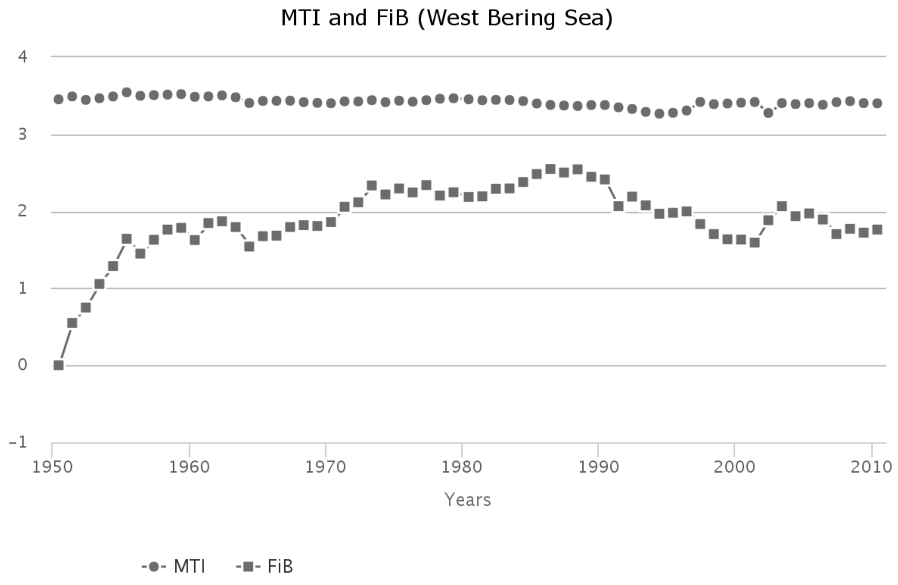


Catch value



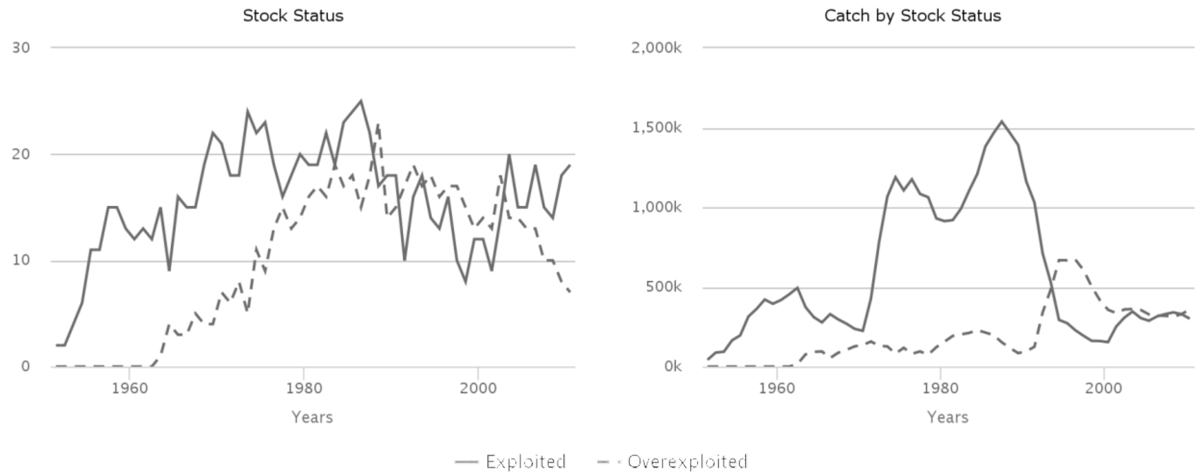
Marine Trophic Index and Fishing-in-Balance index

The MTI has declined since the early 1960s to the late 1980s, suggesting a 'fishing down' of the food webs in the LME, though the decline in the mean trophic level appears to have been compensated for by the increased landings as evident in the positive trend of the FiB index. As the landings in the LME became dominated by Alaska pollock, a high-trophic level species, the mean trophic level began to increase, but with catches and FiB decreasing.



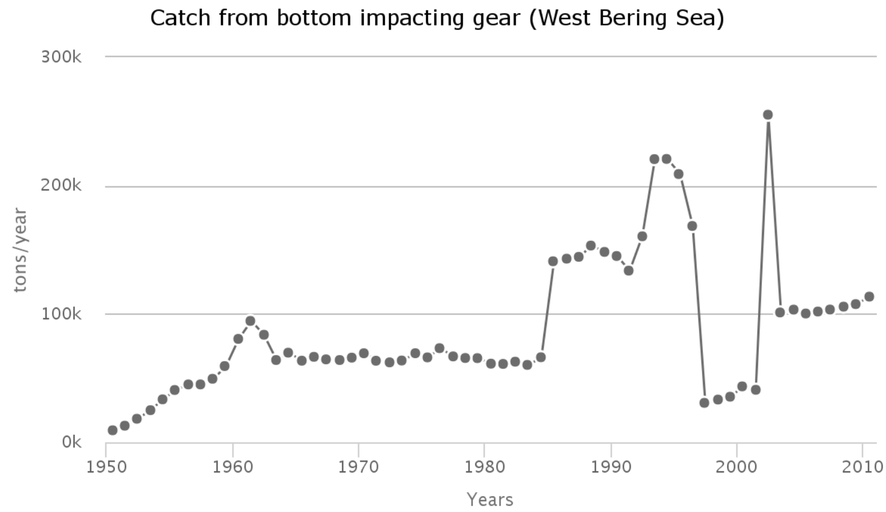
Stock status

The Stock-Catch Status Plots indicate that more than 25% of the exploited stocks in the LME have collapsed, with another 10% overexploited. The reported landings in the region are mostly supplied by the overexploited and fully exploited stocks (about 80% of the total catch).



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 3 and 17% from 1950 to 2010. This percentage fluctuated around 9% in the recent decade.

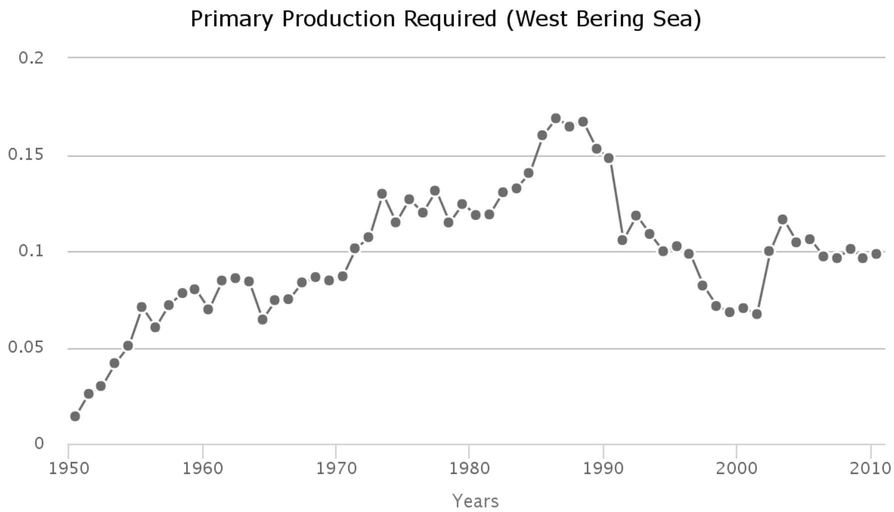


Fishing effort

The total effective effort continuously increased from around 1 million kW in the 1950s to its peak around 13 million kW in 2005.

Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME reached 12 % of observed primary production in the late 1980s, but has declined in recent years.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.
An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a “current trends” scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	1	1	1	1	1	1	1	1

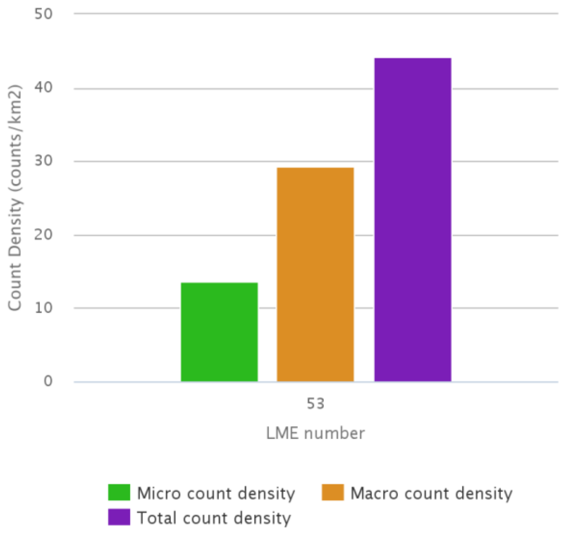
Legend:
Very low Low Medium High Very high

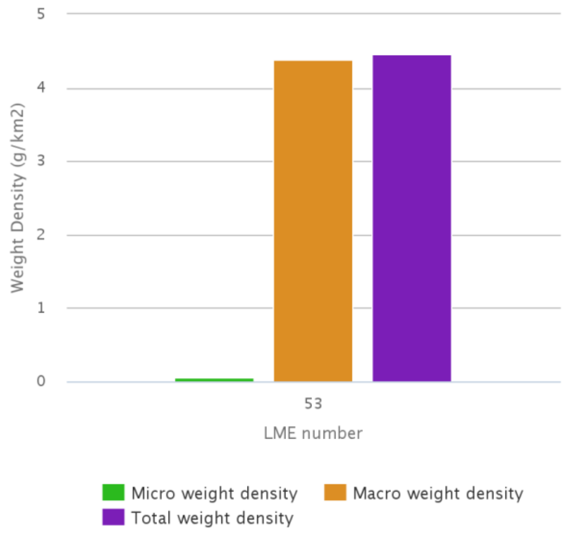
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the lowest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The low values are due to the remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be over 400 times lower than those LMEs with the highest values. There is very limited evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

Not applicable.

Reefs at risk

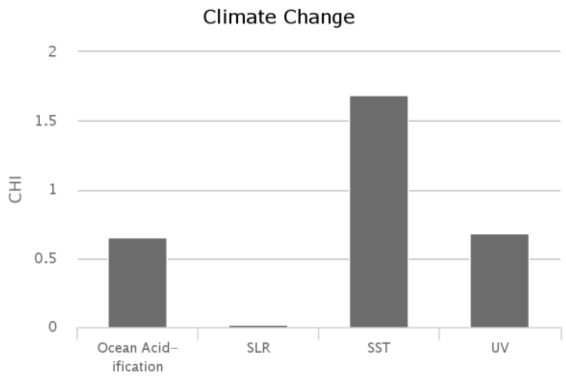
Not applicable.

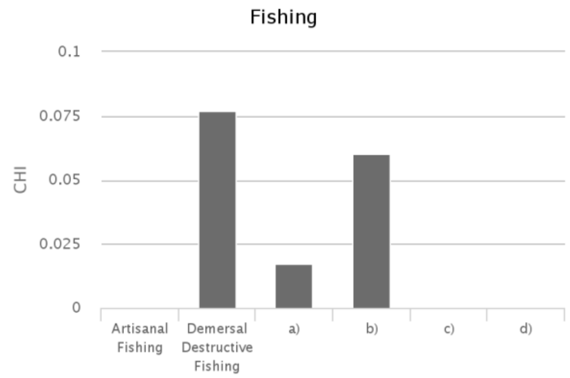
Marine Protected Area change

The West Siberian Sea LME experienced an increase in MPA coverage from 1,327 km^2 prior to 1983 to 12,098 km^2 by 2014. This represents an increase of 812%, within the low category of MPA change.

Cumulative Human Impact

The West Bering Sea LME experiences average overall cumulative human impact (score 3.44; maximum LME score 5.22), but which is still well above the LME with the least cumulative impact. It falls in risk category 3 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.65; maximum in other LMEs was 1.20), UV radiation (0.69; maximum in other LMEs was 0.76), and sea surface temperature (1.69; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, ocean based pollution, and demersal destructive commercial fishing.





a) Demersal Non-destructive High Bycatch Fishing
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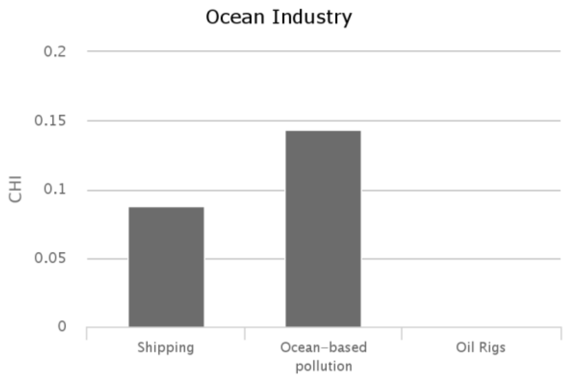
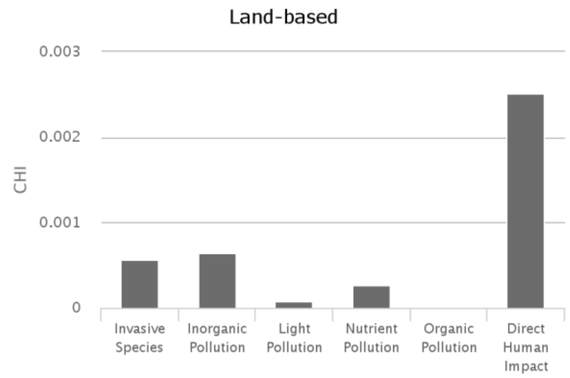
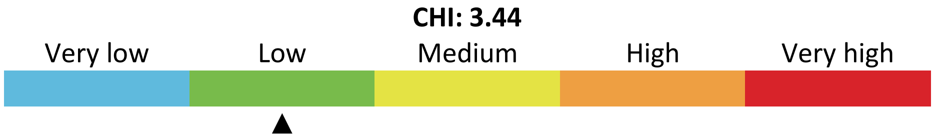


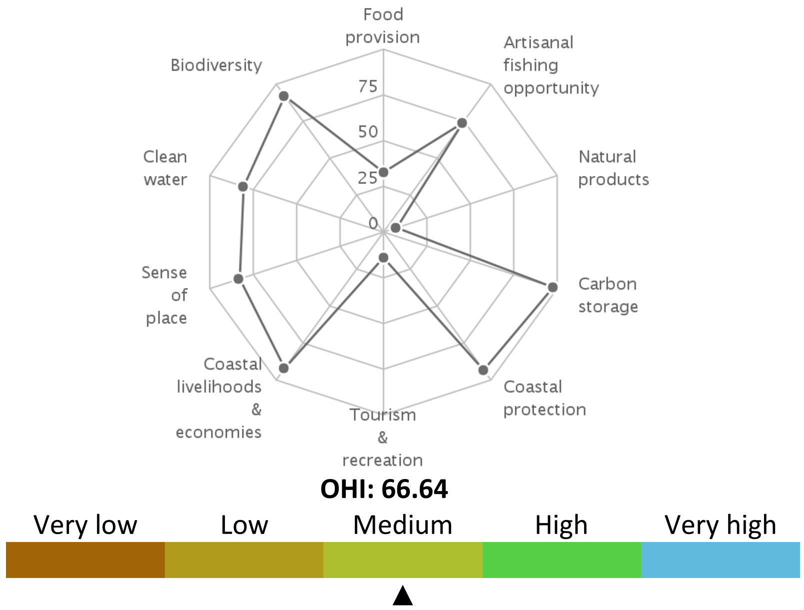




Ocean Health Index

The West Bering Sea LME scores below average on the Ocean Health Index compared to other LMEs (score 68 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 remained unchanged compared to the previous year. This LME scores lowest on food provision, natural products, and tourism & recreation goals and highest on artisanal fishing opportunities, coastal protection, carbon storage, coastal economies, lasting special places and habitat biodiversity goals. It falls in risk category 4 of the five risk categories, which is a relatively high level of risk (1 = lowest risk; 5 = highest risk).

Ocean Health Index (West Bering Sea)



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 232 827 km^2. A current population of 311 thousand in 2010 is projected to decrease to 196 thousand in 2100, with a density of 13 persons per 10 km^2 in 2010 decreasing to 8 per 10 km^2 by 2100. About 31% of coastal population lives in rural areas, and is projected to decrease in share to 25% in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
310,725	196,173	96,838	47,987

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 17% of the LME's coastal dwellers. This LME places in the high-risk category based on percentage and in the low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
52,823

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the high-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $715 million for the period 2001-2010. Fish protein accounts for 14% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$378 million places it in the very low-revenue category. On average, LME-based tourism income contributes 6% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (*e.g.* spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the high-risk category.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
714,896,683	14.0	378,077,280	6.1	0.8063

Legend:

Very low | Low | Medium | High | Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the high HDI and low-risk category. Based on an HDI of 0.782, this LME has an HDI Gap of 0.218, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a very high-risk category (very low HDI) because of reduced income levels and population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.7818	0.8951	0.6076

Legend:

Very low | Low | Medium | High | Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the high-risk (high threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is medium. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to low under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.6424	0.3300	0.3131	0.4970

Legend:

Very low | Low | Medium | High | Very high

Governance

Governance architecture

Transboundary issues of concern in this LME are addressed by the Arctic Council, primarily due to its integrative nature. However, while it does appear that the Arctic Council has the potential to develop into an informal overall policy coordinating organization; its policy coordination role with respect to fisheries is weak.

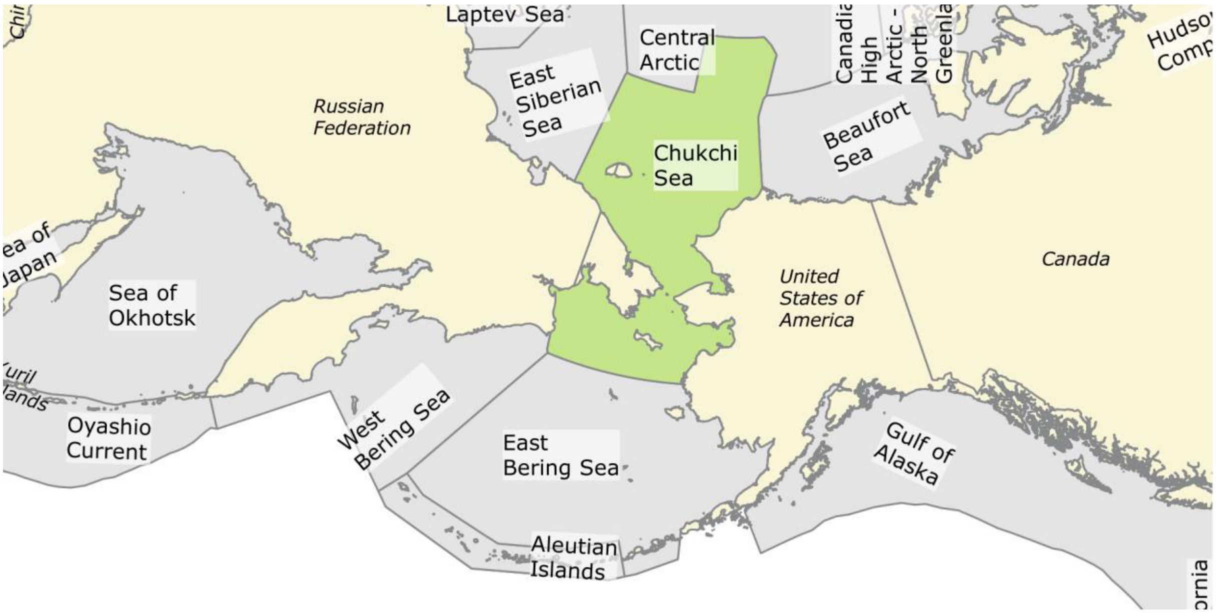
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
100	**60**	**0.3**

Legend:

Very low | Low | Medium | High | Very high

LME 54 – Chukchi Sea



Bordering countries: United States of America, Russian Federation.
LME Total area: 783,245 km^2

List of indicators

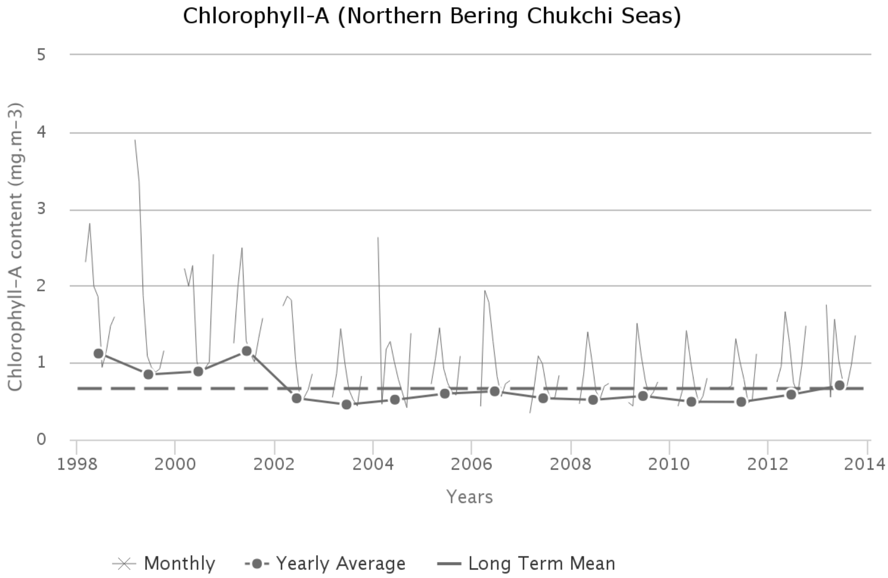
LME overall risk

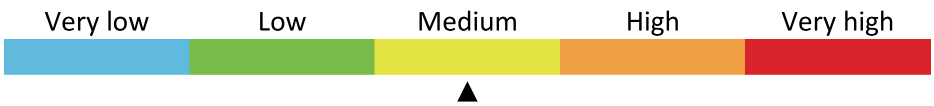
This LME falls in the cluster of LMEs that exhibit high percentages of rural coastal population, high numbers of collapsed and overexploited fish stocks, as well as high proportions of catch from bottom impacting gear.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is low.

Productivity

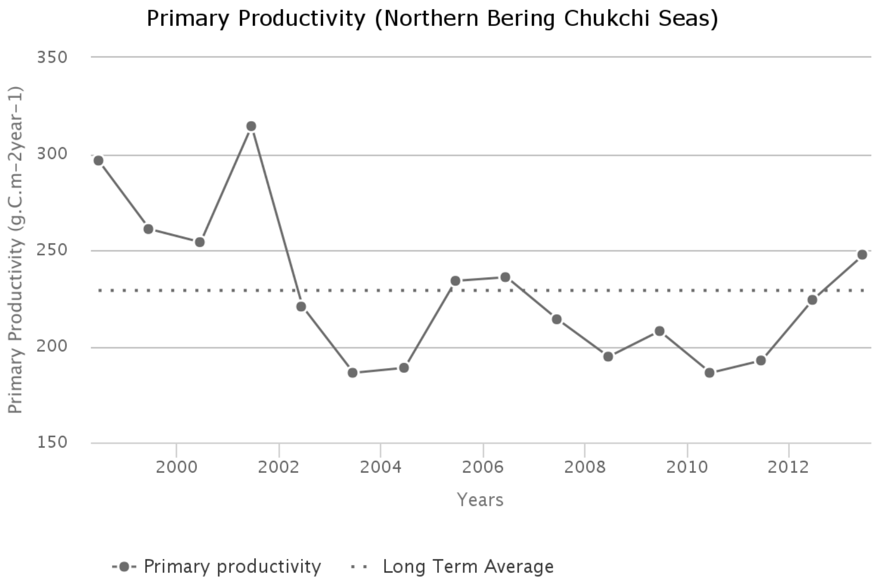
Chlorophyll-A

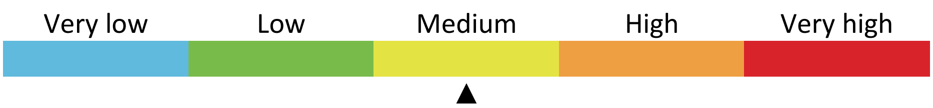
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (2.63 mg.m^{-3}) in February and a minimum (0.480 mg.m^{-3}) during September. The average CHL is 0.664 mg.m^{-3}. Maximum primary productivity (314 g.C.m^{-2}.y^{-1}) occurred during 2001 and minimum primary productivity (186 g.C.m^{-2}.y^{-1}) during 2010. There is a statistically insignificant decreasing trend in Chlorophyll of -19.0 % from 2003 through 2013. The average primary productivity is 229 g.C.m^{-2}.y^{-1}, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).





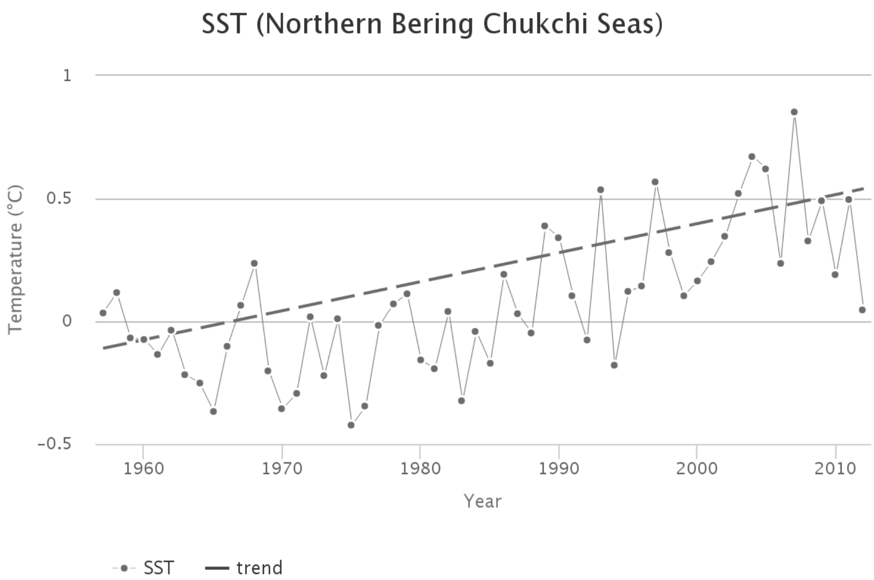
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Northern Bering-Chukchi Sea LME #54 has warmed by 0.65°C, thus belonging to Category 3 (moderate warming LME). The absolute minimum of <-0.4°C was reached in 1983. Such cold SSTs have not been approached after 1994. The SST warming rate between the coldest event of -0.4°C in 1983 and the warmest event of 0.8°C in 2007 was 1.2°C in 24 years. The recent years saw a reversal that began in 2008 after the all-time peak of >0.8°C in 2007. The recent cooling in the Chukchi Sea parallels a similar cooling in the Bering Sea. This synchronism can be expected given the connection between these two seas via the Bering Strait. As the Chukchi Sea was quickly losing its summer sea ice cover in a recent decade (apparently due to global warming, whose magnitude is amplified in the Arctic), the Chukchi Sea SST was expected to rise. Therefore, the recent cooling trend observed in LME #54 can only be explained by the concomitant cooling in the northern Bering Sea, exacerbated by the contemporaneous cooling in the East Bering Sea LME #1.

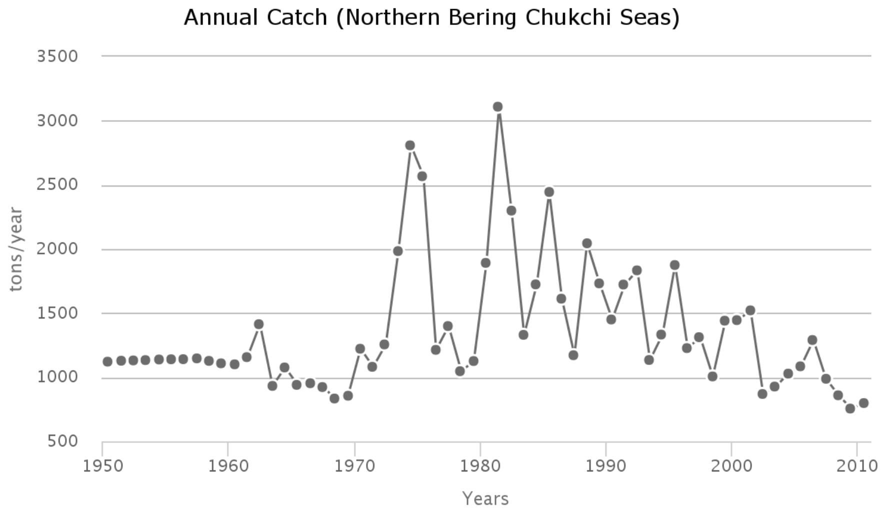


Fish and Fisheries

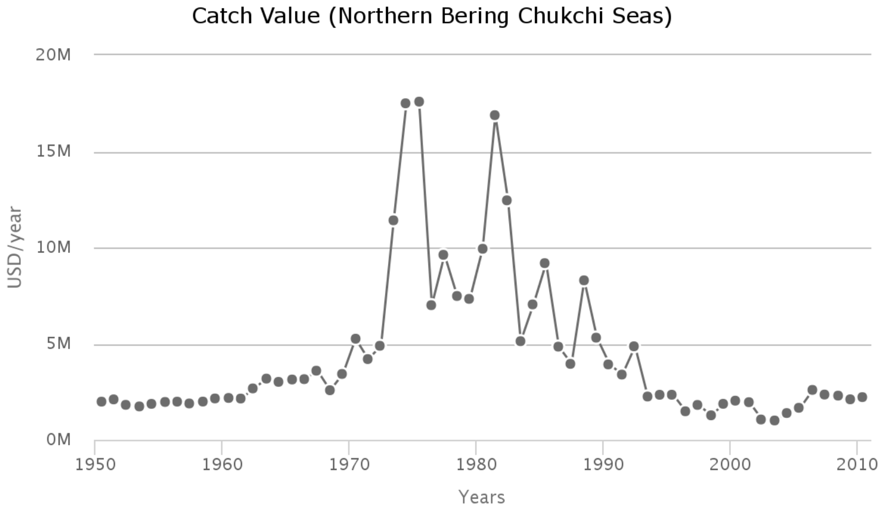
Key marine species in this LME are salmon (*Oncorhynchus spp.*), herring (*Clupea pallasii pallasii*), walrus (*Odobenus rosmarus*), seals, whales and various species of waterfowl. The key subsistence marine species are likely to undergo shifts in range and abundance due to climate change. The central and eastern Arctic Seas do not have a significant fishing industry, except near coastal areas. Very scarce data are available from the Russian part of the Chukchi Sea, which is only sparsely populated.

Annual Catch

The catch appears to consist overwhelmingly of salmonids. This is similar for the catch from the Alaskan part of the Chukchi Sea, i.e., taken north of Cape Prince of Wales on the Seward Peninsula, which are collected from commercial, subsistence and sport fisheries by Alaska's Department of Fish and Game. These catches were assembled and added to the catch estimate from the Russian part of the Chukchi Sea. The overall annual catch from the Chukchi Sea range fluctuate between 36,000 t and 500,000 t and consist predominantly of salmonids.



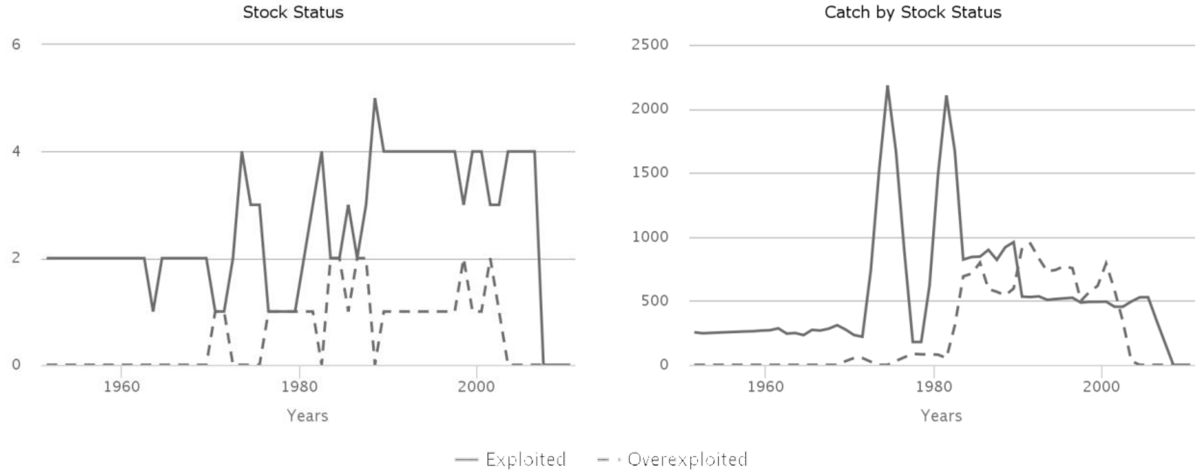
Catch value



Marine Trophic Index and Fishing-in-Balance index

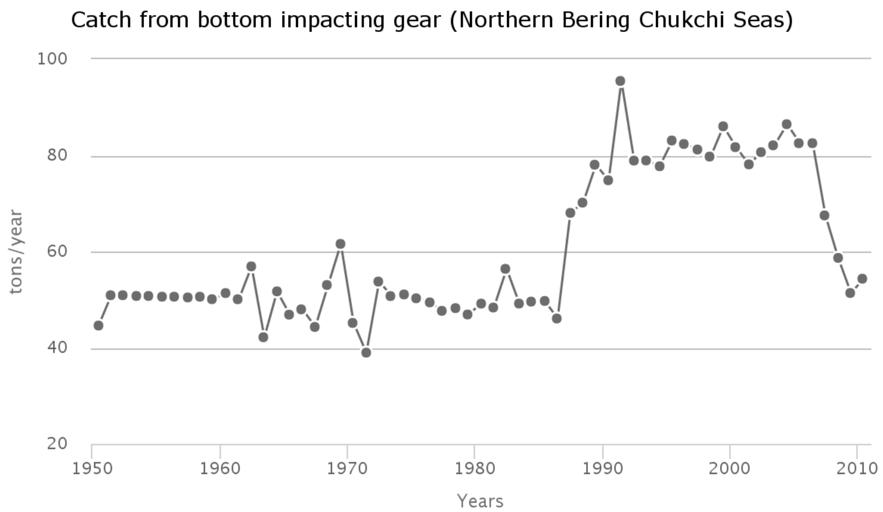
Given the very low quality of the underlying catch data, the catch-based indicators for this LME (such as PPR, MTI or FiB) are likely to be very unreliable.

Stock status



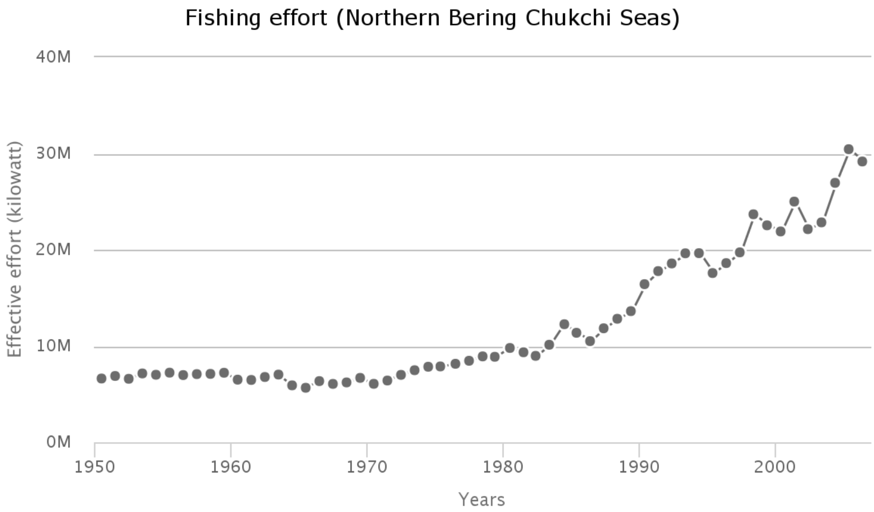
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch reached its first peak at 19% in 1964 and then fluctuated around 11% in recent decade.



Fishing effort

The total effective effort continuously increased from around 7 million kW in the 1950s to its peak around 30 million kW in 2005.



Primary Production Required
Given the very low quality of the underlying catch data, the catch-based indicators for this LME (such as PPR, MTI or FiB) are likely to be very unreliable.

Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator
Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.
An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load
The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a “current trends” scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio
The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

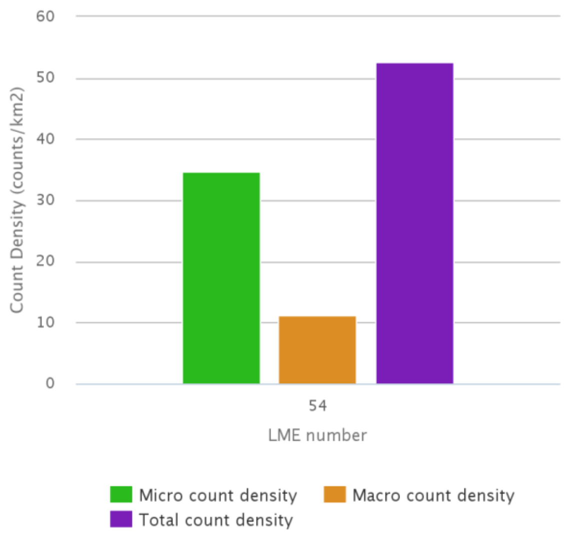
Merged nutrient indicator
The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

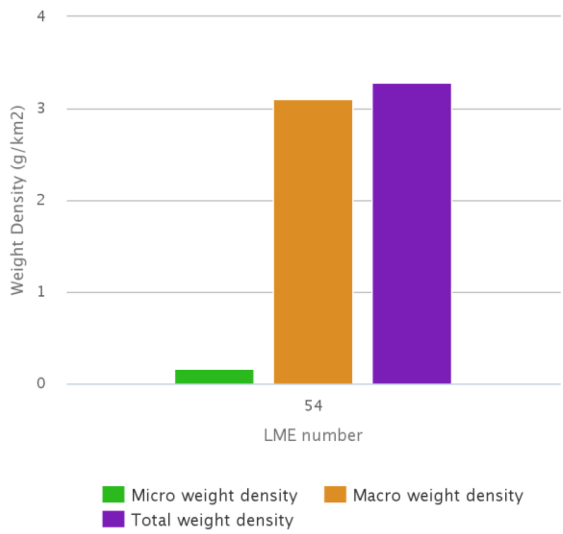
2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	2	1	1	2	1	1	2	1

Legend: Very low, Low, Medium, High, Very high

POPs
No pellet samples were obtained from this LME.

Plastic debris
Modelled estimates of floating plastic abundance (items km-2), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the lowest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The low values are due to the remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be over 400 times lower than those LMEs with the highest values. There is very limited evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

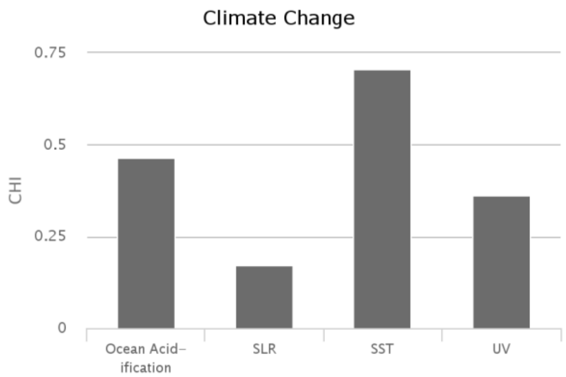
Mangrove and coral cover
Not applicable.

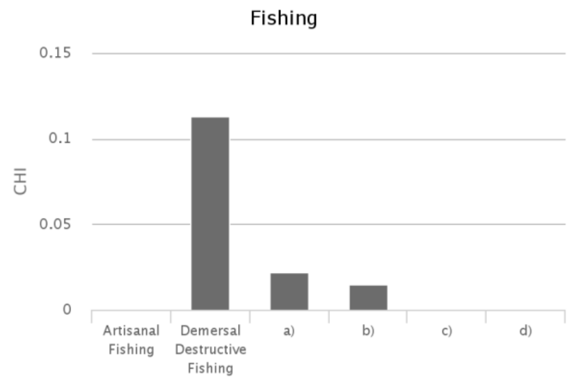
Reefs at risk
Not applicable.

Marine Protected Area change
The North Bering – Chukchi Seas LME experienced an increase in MPA coverage from 15,169 km^2 prior to 1983 to 15,672 km^2 by 2014. This represents an increase of 3%, within the lowest category of MPA change.

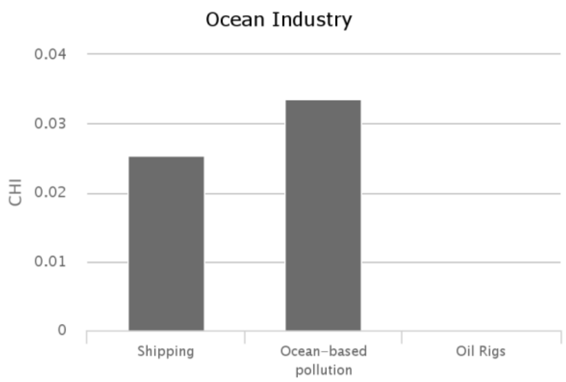
Cumulative Human Impact

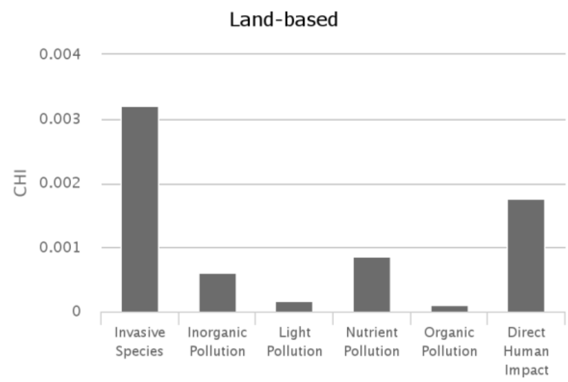
The Northern Bering – Chukchi Seas LME experiences below average overall cumulative human impact (score 1.92; maximum LME score 5.22), but which is still above the LME with the least cumulative impact. It falls in risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, all four connected to climate change have the highest average impact on the LME: ocean acidification (0.46; maximum in other LMEs was 1.20), UV radiation (0.36; maximum in other LMEs was 0.76), sea level rise (0.17; maximum in other LMEs was 0.71), and sea surface temperature (0.71; maximum in other LMEs was 2.16). Other key stressors include ocean based pollution and demersal destructive commercial fishing.

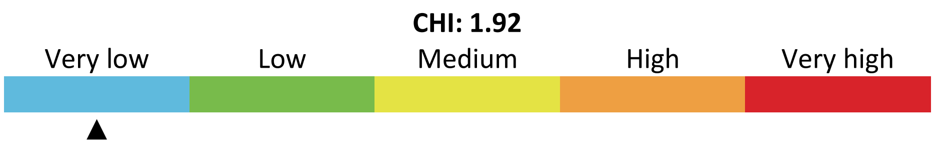




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing



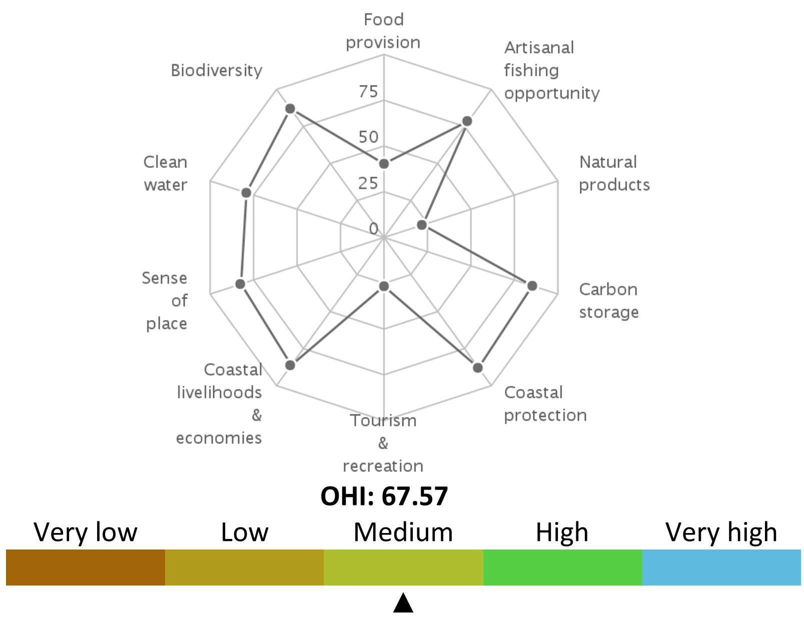




Ocean Health Index

The Northern Bering – Chukchi Seas LME scores below average on the Ocean Health Index compared to other LMEs (score 70 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 3 points compared to the previous year, due in large part to changes in the scores for clean waters and coastal livelihoods. This LME scores lowest on food provision, natural products, and tourism & recreation goals and highest on artisanal fishing opportunities, coastal economies, and lasting special places goals. It falls in risk category 3 of the five risk categories, which is an average level of risk (1 = lowest risk; 5 = highest risk).

Ocean Health Index (Northern Bering Chukchi Seas)



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 493 726 km^2. A current population of 56 thousand in 2010 is projected to decrease to 46 thousand in 2100, with a density of 11 persons per 100 km^2 in 2010 decreasing to 9 per 100 km^2 by 2100. About 100% of coastal population lives in rural areas, and is projected to be the same in share in 2100.

Total population		Rural population	
2010	2100	2010	2100
56,490	45,969	56,490	45,969

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 17% of the LME's coastal dwellers. This LME places in the high-risk category based on percentage and in the very low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
9,646

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the medium-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $328 million for the period 2001-2010. Fish protein accounts for 10% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$4 759 million places it in the low-revenue category. On average, LME-based tourism income contributes 8% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the medium-risk category.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
327,890,066	10.4	4,759,031,758	8.4	0.7088

Legend:
Very low Low Medium High Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.856, this LME has an HDI Gap of 0.144, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a high-risk category (low HDI) because of reduced income levels and population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.8557	0.9355	0.6588

Legend:
Very low Low Medium High Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the medium-risk (medium threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is low. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to low under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
0.5766	0.2909	0.2813	0.4857

Legend:

Very low Low Medium High Very high

Governance

Governance architecture

While the halibut (IPHC) and polar bear (ACPB) arrangements do not appear to be connected, the arrangement for land-based and marine-based pollution, biodiversity in general and fisheries under the Arctic Council is well-integrated. However, since the Arctic Council is not constituted under a convention, it is limited in terms of its ability to create any binding agreements and is dependent on countries to implement its recommendations. However, this LME has been assigned an overall integration score of 1.0 due to the presence of the Arctic Council.

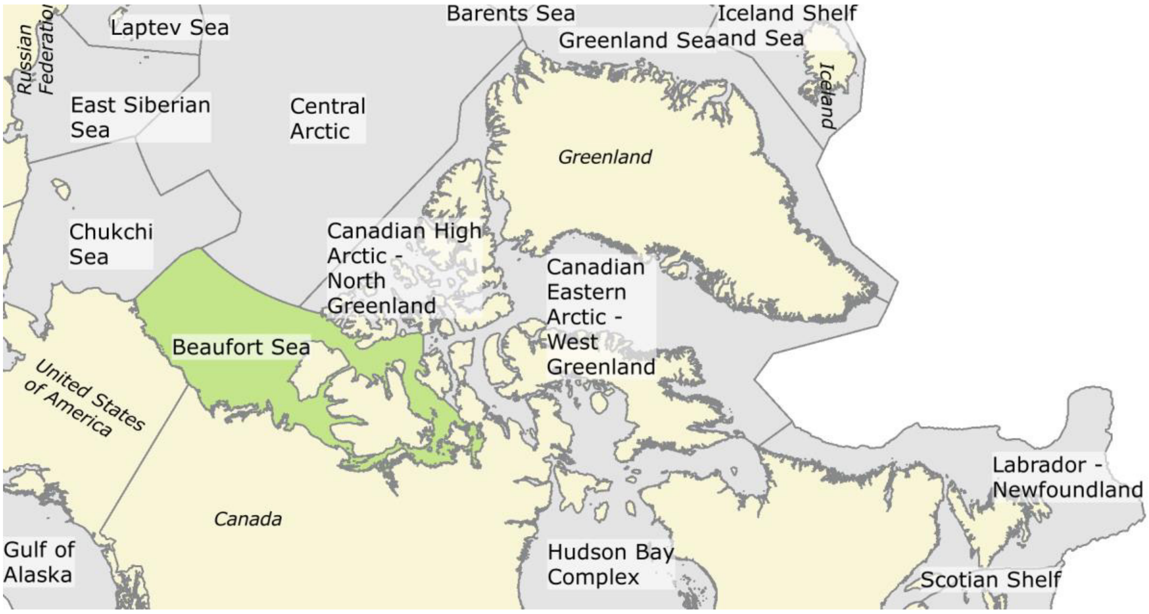
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
88	69	1

Legend:

Very low Low Medium High Very high

LME 54 – Beaufort Sea



Bordering countries: Canada, United States of America.
LME Total area: 664,752 km^2

List of indicators

LME overall risk

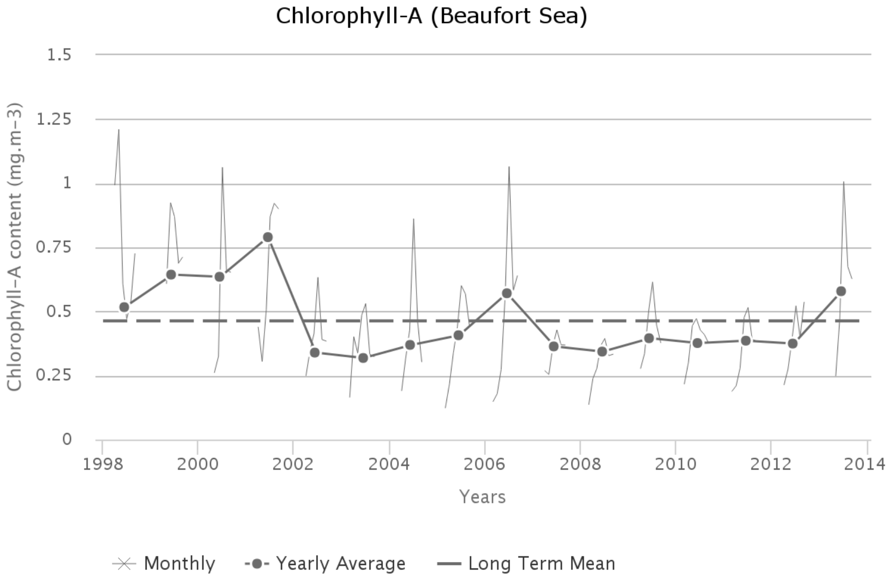
This LME falls in the cluster of LMEs that exhibit high percentages of rural coastal population, high numbers of collapsed and overexploited fish stocks, as well as high proportions of catch from bottom impacting gear.

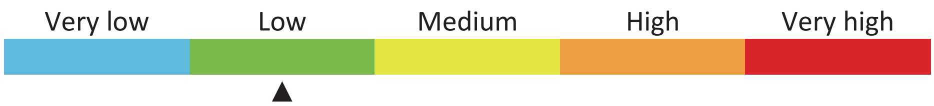
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very low..

Productivity

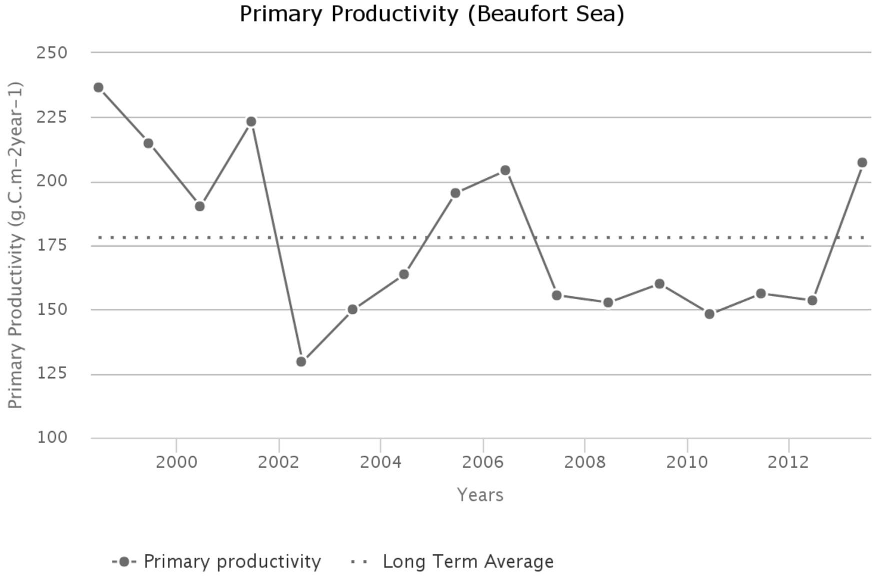
Chlorophyll-A

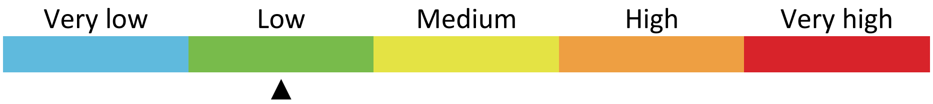
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.404 mg.m^{-3}) in July and a minimum (0.137 mg.m^{-3}) during March. The average CHL is 0.463 mg.m^{-3}. Maximum primary productivity (237 g.C.m^{-2}.y^{-1}) occurred during 1998 and minimum primary productivity (130 g.C.m^{-2}.y^{-1}) during 2002. There is a statistically insignificant decreasing trend in Chlorophyll of -15.0 % from 2003 through 2013. The average primary productivity is 178 g.C.m^{-2}.y^{-1}, which places this LME in Group 2 of 5 categories (with 1 = lowest and 5= highest).





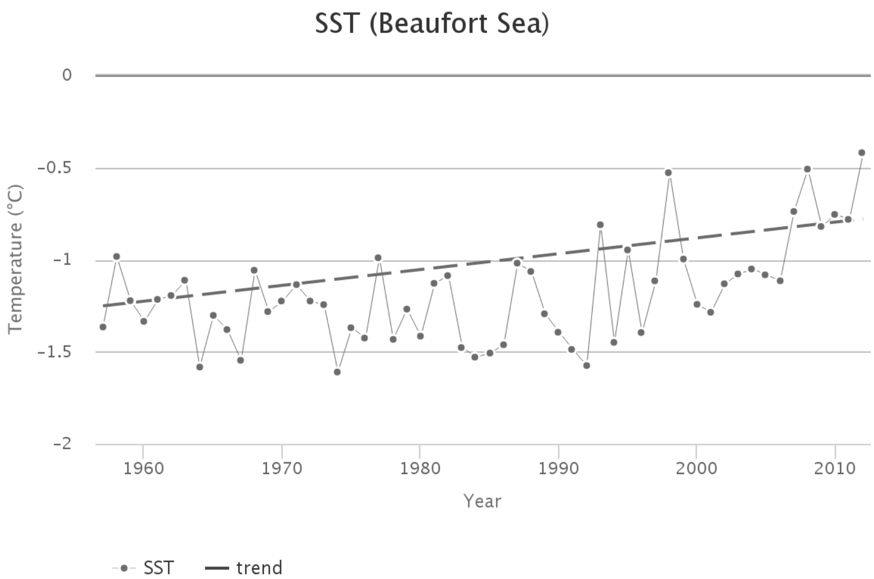
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Beaufort Sea LME #55 has warmed by 0.47°C, thus belonging to Category 3 (moderate warming LME). The Beaufort Sea's annual variability of SST was rather small, <0.5°C. The only significant event occurred in 1998, when SST exceeded -0.6°C. Comparison of SST time series with the Arctic Oscillation (AO) index suggests a strong correlation between SST and AO index, with negative SST anomalies corresponding to positive values of AO index. There are some similarities between thermal histories of the Beaufort and Chukchi Seas. In both cases, there was no warming until the end of the 20th century. In the Chukchi Sea, a transition to a warming regime occurred in 1983, whereas in the Beaufort Sea a similar transition to a warming regime commenced a decade later, resulting in an SST increase from nearly -1.6°C in 1992 to -0.5°C in 2012.

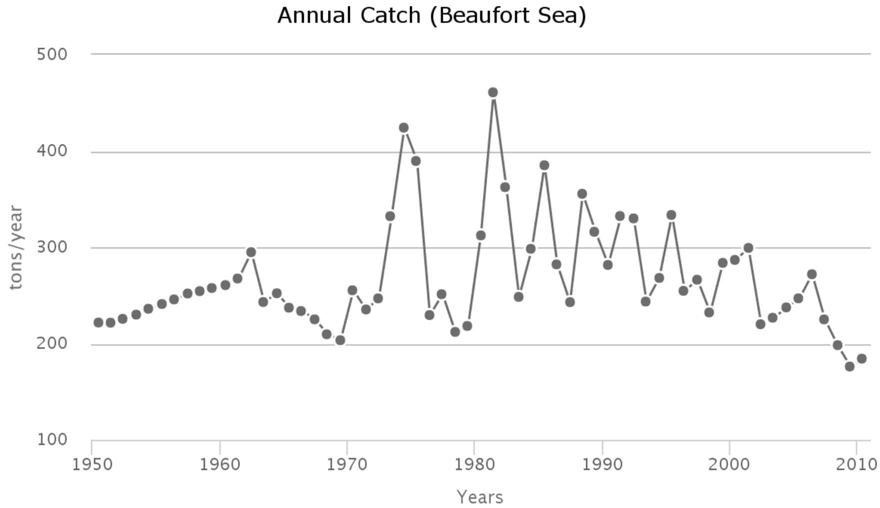


Fish and Fisheries

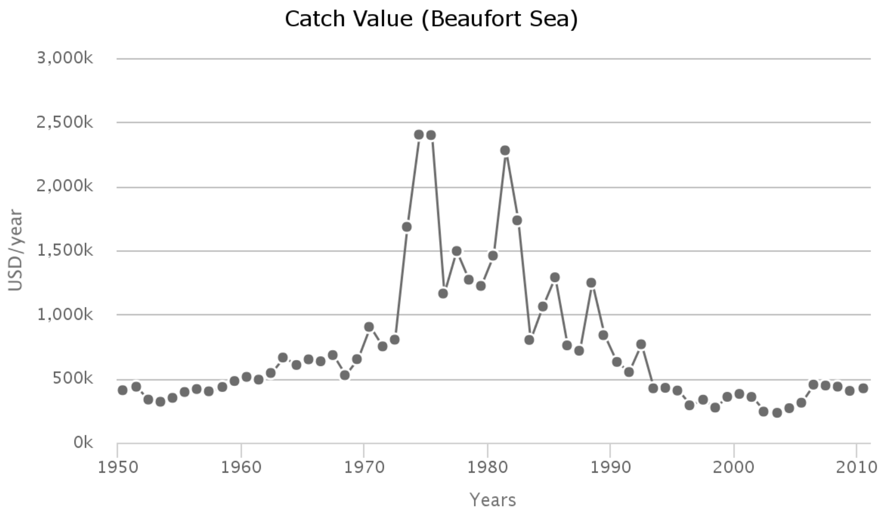
There are three coastal communities (Tuktoyaktuk, Sachs Harbour and Kaktovik) and two inland communities (Aklavik and Inuvik) that make use of the Beaufort Sea, largely for subsistence, but also some commercial fisheries occur in Canadian waters. The catch data from this LME are too crude for ecosystem indicators such as PPR, MTI or FiB index to be computed.

Annual Catch

Catches peaked in 1981 at approximately 453 t and were estimated at approximately 224 t in the recent decade. Important species include Dolly varden (*Salvelinus malma*), whitefish (*Coregonidae*) and two other species, inconnu (*Stenodus leucichthys*) and Pacific herring (*Clupea pallasii*), which are of lesser importance.



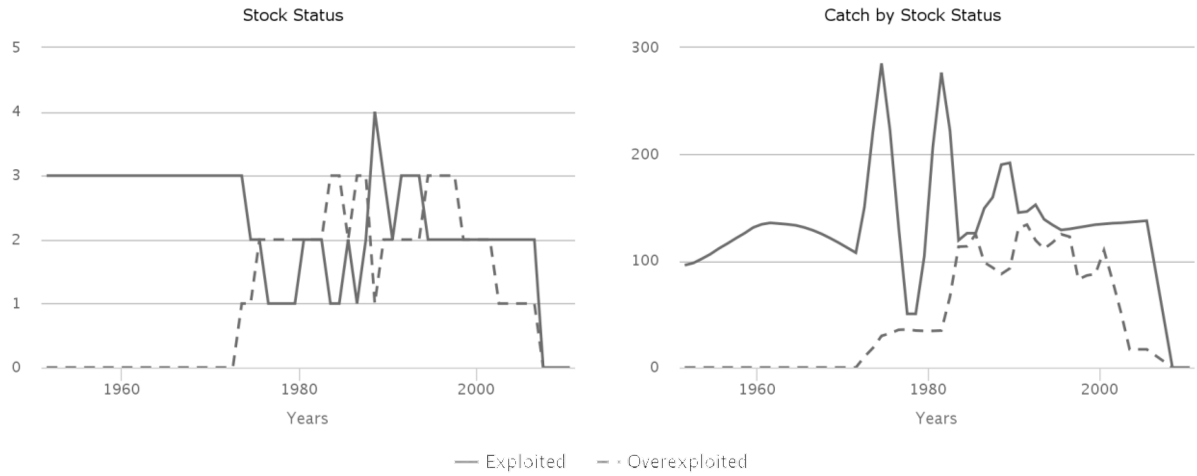
Catch value



Marine Trophic Index and Fishing-in-Balance index

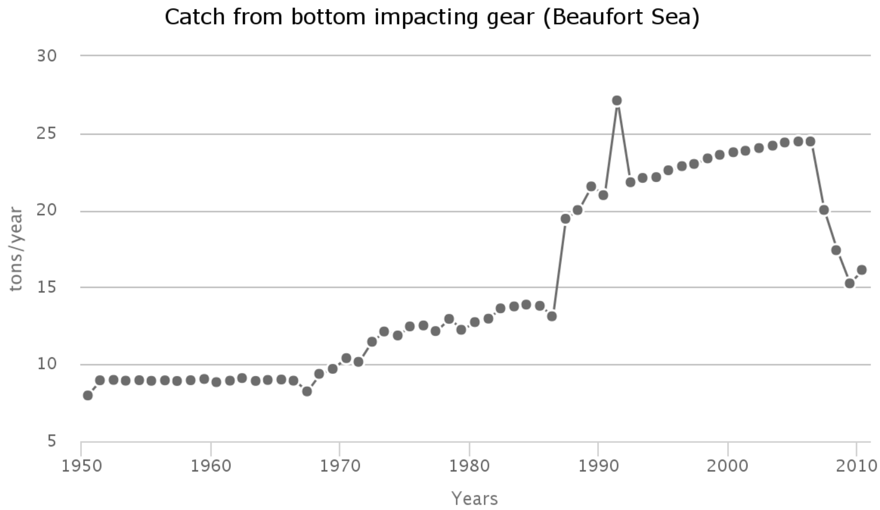
Given the very low quality of the underlying catch data, the catch-based indicators for this LME (such as PPR, MTI or FiB) are likely to be very unreliable.

Stock status



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch increased from 3% in the early 1950s to the peak at around 11% in 2001. Then, this percentage fluctuated around 9% in recent decade.



Fishing effort

No effort data is available in this LME.

Primary Production Required

Given the very low quality of the underlying catch data, the catch-based indicators for this LME (such as PPR, MTI or FiB) are likely to be very unreliable.

Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering

LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.
An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	3	1	1	3	1	1	3	1

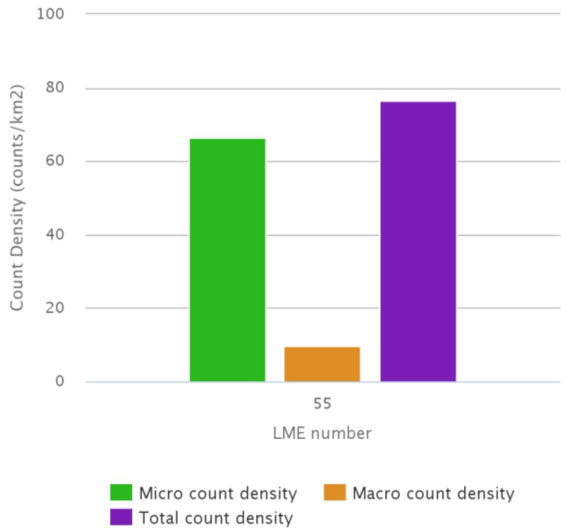
Legend: Very low, Low, Medium, High, Very high

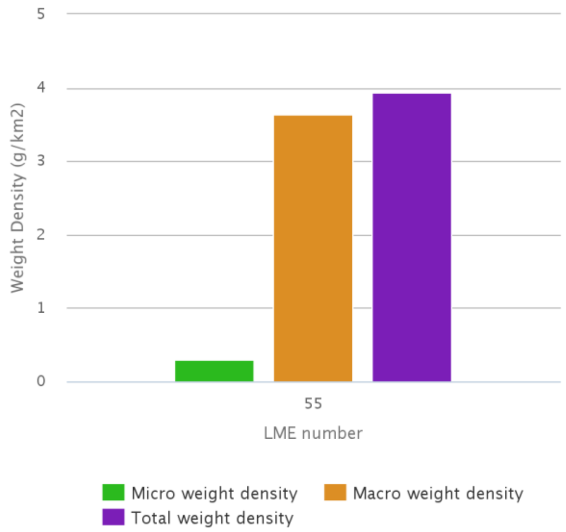
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the lowest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The low values are due to the remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be over 400 times lower than those LMEs with the highest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

Not applicable.

Reefs at risk

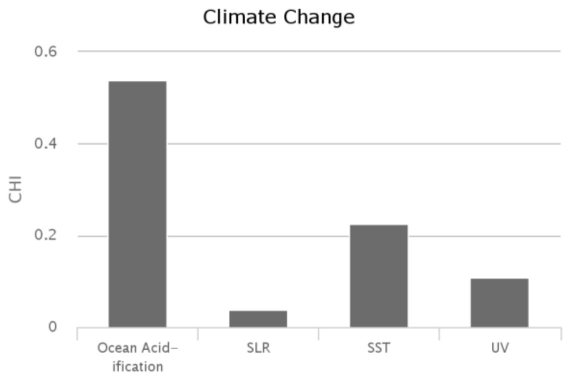
Not applicable.

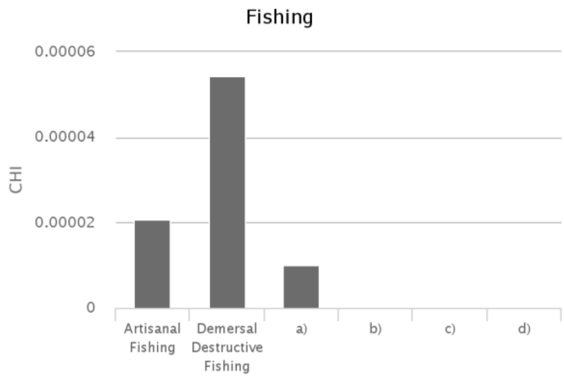
Marine Protected Area change

The Beaufort Sea LME experienced an increase in MPA coverage from 10,030 km^2 prior to 1983 to 11,844 km^2 by 2014. This represents an increase of 18%, within the lowest category of MPA change.

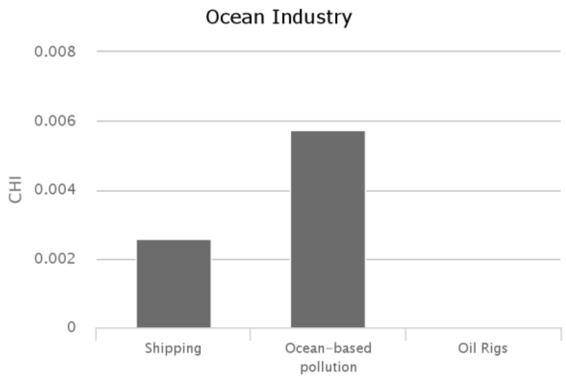
Cumulative Human Impact

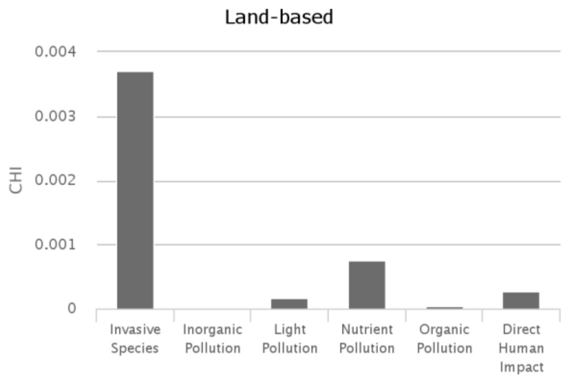
The Beaufort Sea LME experiences one of the lowest overall cumulative human impact (score 0.93; maximum LME score 5.22). It falls in risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.54; maximum in other LMEs was 1.20), UV radiation (0.11; maximum in other LMEs was 0.76), and sea surface temperature (0.23; maximum in other LMEs was 2.16). The only other key stressor is sea level rise.

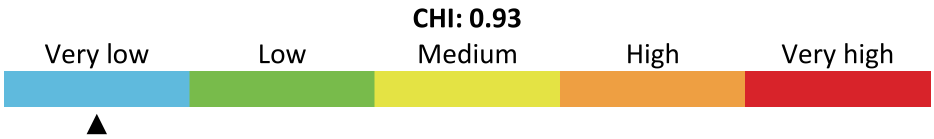




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

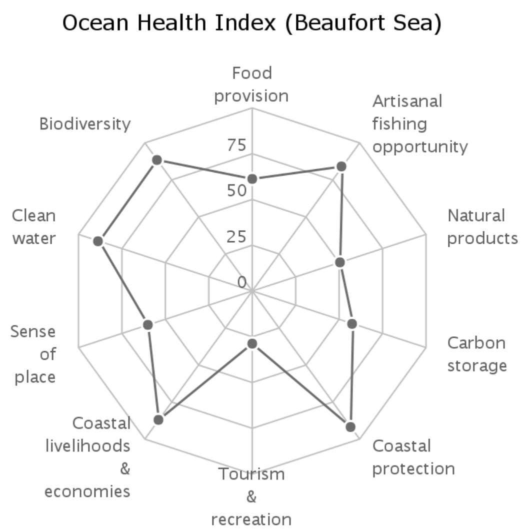






Ocean Health Index

The Beaufort Sea LME scores above average on the Ocean Health Index compared to other LMEs (score 71 out of 100; range for other LMEs was 57 to 82), but still relatively low. This score indicates that the LME is below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 4 points compared to the previous year, due in large part to changes in the score for clean waters. This LME scores lowest on fisheries, natural products, carbon storage, tourism & recreation, and lasting special places goals and highest on artisanal fishing opportunities, coastal protection and coastal economies goals. It falls in risk category 3 of the five risk categories, which is an average level of risk (1 = lowest risk; 5 = highest risk).



OHI: 69.79

Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 974 278 km^2. A current population of 18 thousand in 2010 is projected to decrease to 8 thousand in 2100, with a density of 2 persons per 100 km^2 in 2010 decreasing to 1 per 100 km^2 by 2100. About 100% of coastal population lives in rural areas, and is projected to be the same in share in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
18,042	7,938	17,987	7,919

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 14% of the LME's coastal dwellers. This LME places in the low-risk category based on percentage and in the very low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
2,473

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $0.42 million for the period 2001-2010. Fish protein accounts for 9% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$16 299 million places it in the medium-revenue category. On average, LME-based tourism income contributes 6% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with low risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
417,730	8.9	16,298,971,350	6.1	0.6842

Legend: Very low | Low | Medium | High | Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.903, this LME has an HDI Gap of 0.097, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a medium-risk category (medium HDI) because of reduced income levels and population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.9027	0.9709	0.7391

Legend: Very low | Low | Medium | High | Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the low-risk (low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very low. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and maintains this even under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.4270	0.2175	0.2029	0.4133

Legend:

Very low Low Medium High Very high

Governance

Governance architecture

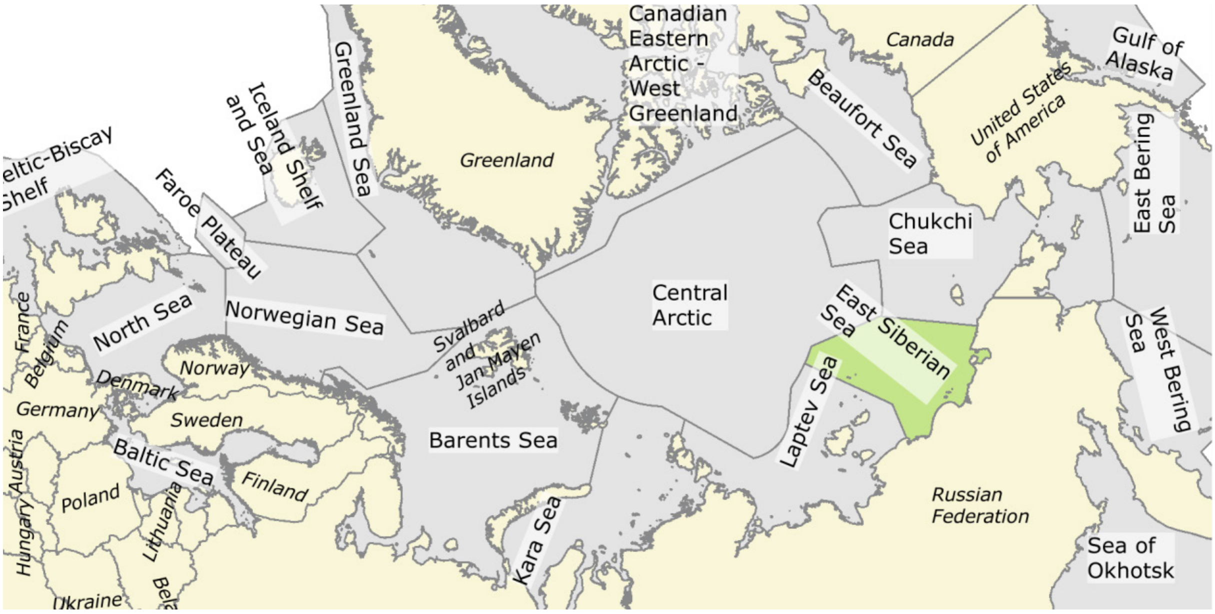
For this LME, the only transboundary agreement addressing the issues is the Arctic Council (AC). It appears that the AC has the potential to develop into an informal overall policy coordinating organization, its policy coordination role with respect to fisheries is weak. Nevertheless, this LME has been assigned an overall integration score of 1.0 due to the presence of the Arctic Council.
The overall scores for the ranking of risk were:

Engagement	Completeness	Integration
100	**67**	**1**

Legend:

Very low Low Medium High Very high

LME 56 – East Siberian Sea



Bordering countries: Russian Federation.
LME Total area: 1,024,100 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit high percentages of rural coastal population, high numbers of collapsed and overexploited fish stocks, as well as high proportions of catch from bottom impacting gear.

Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is medium.

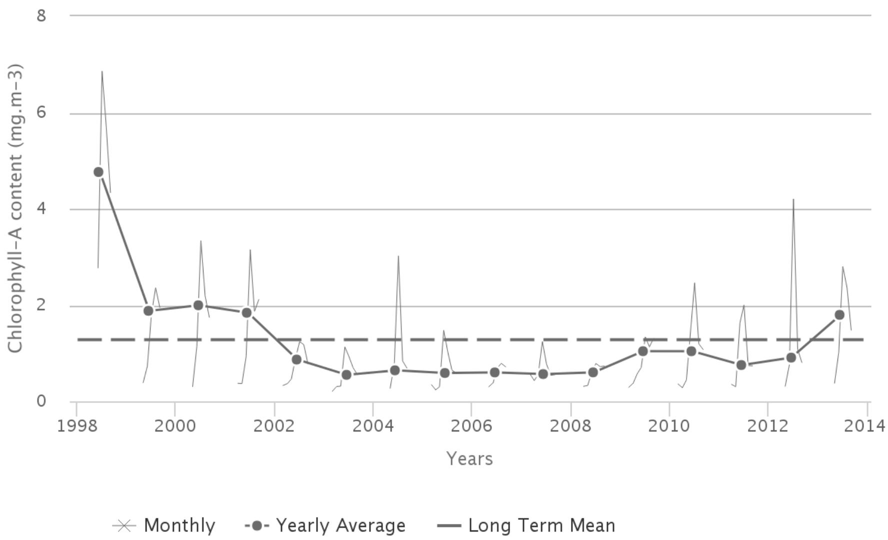
Very low | Low | Medium | High | Very high

Productivity

Chlorophyll-A

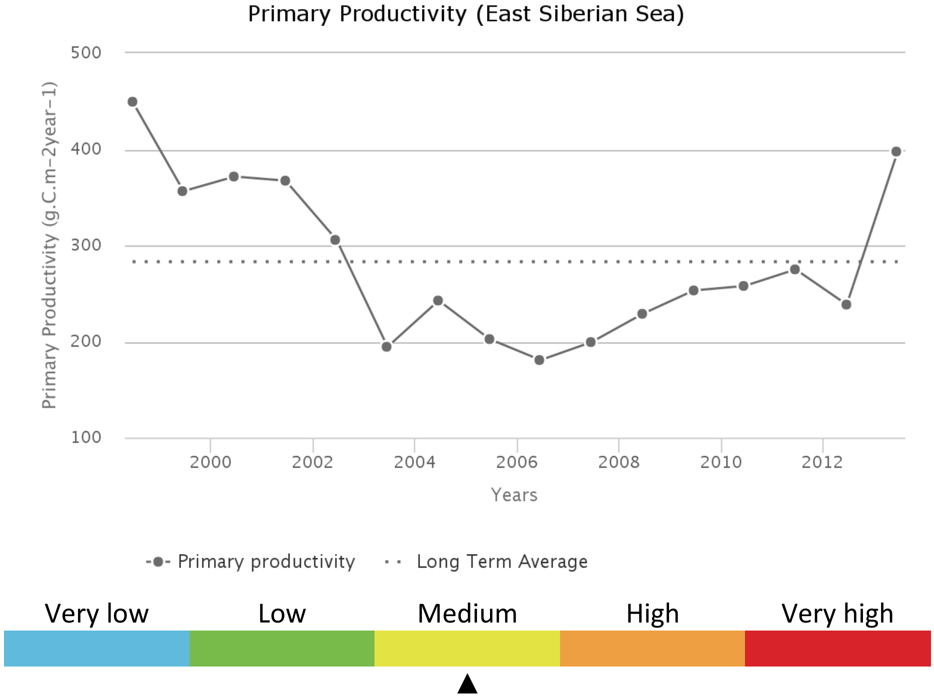
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.689 $mg.m^{-3}$) in July and a minimum (0.356 $mg.m^{-3}$) during April. The average CHL is 1.28 $mg.m^{-3}$. Maximum primary productivity (449 $g.C.m^{-2}.y^{-1}$) occurred during 1998 and minimum primary productivity (181 $g.C.m^{-2}.y^{-1}$) during 2006. There is a statistically insignificant decreasing trend in Chlorophyll of -1.11 % from 2003 through 2013. The average primary productivity is 283 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).

Chlorophyll-A (East Siberian Sea)



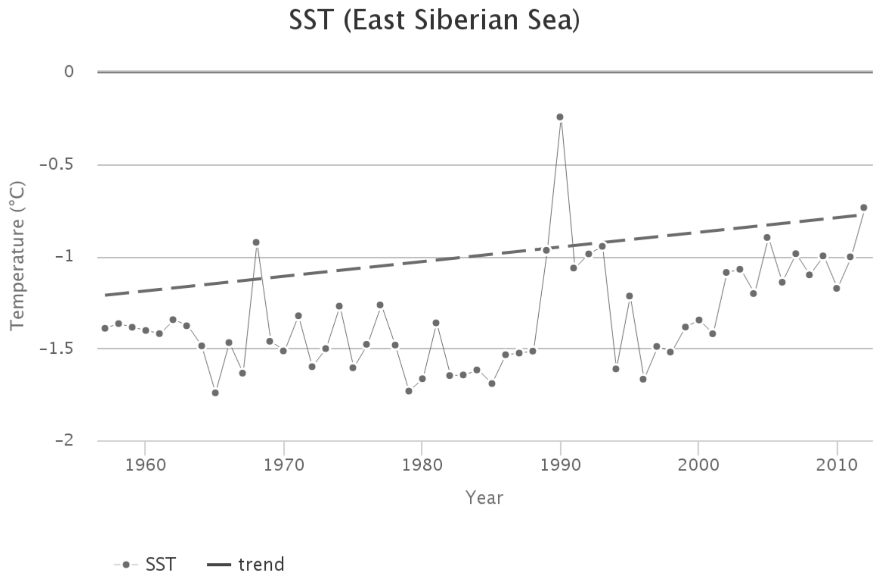
Very low | Low | Medium | High | Very high

Primary productivity



Sea Surface Temperature

From 1957 to 2012, the East Siberian Sea LME #56 has warmed by 0.44°C, thus belonging to Category 3 (moderate warming LME). The East Siberian Sea's interannual variability of SST was very small, typically around 0.2-0.4°C. The only major event occurred in 1988-90, when SST rose by 1°C in just two years, reaching -0.3°C in 1990, thus exceeding by 1.4°C the all-time minimum of <-1.7°C in 1979. This event nearly coincided with the largest increase of the Arctic Oscillation (AO) index on record since 1950. The thermal history of this LME featured a regime shift from a cold epoch in 1957-1996 to a warm epoch afterward. During the warm epoch, SST has been rising steadily through 2012.

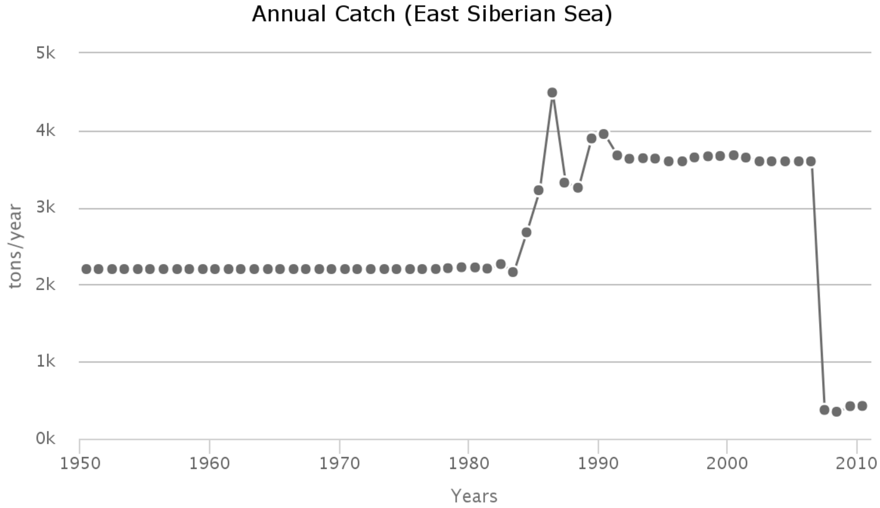


Fish and Fisheries

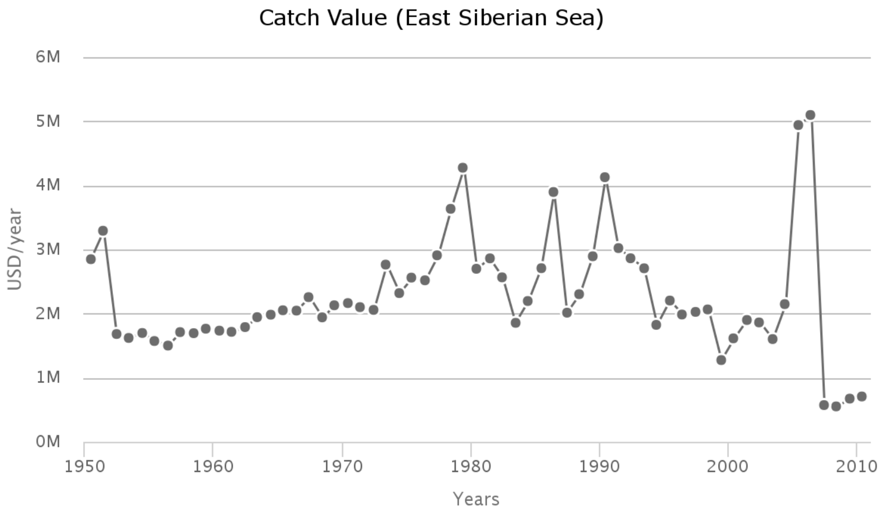
The number of species and stocks of biological resources in the East Siberian Sea LME is small. Several valuable fish species are found in this LME, but the largest stocks are generally concentrated in sub-estuarial zones. Much of the salmon catch is low-grade pink salmon that is canned and sold domestically. Valuable species such as pollock, halibut and crab are poised to play a more important commercial role. As in the Kara and Laptev seas, whitefish species (genus Coregonus), called "sig" in Russian, form the bulk of the fishery in this LME, but detailed records are available only from the lower reaches of the Indigirka and Kolyma Rivers for the years from 1981 to 1990.

Annual Catch

These data, amounting to about 1,500 t per year on average, do not show any consistent trend, and in the absence of other data which may support an alternative estimation procedure, these data were extrapolated both backward to 1950, and forward.



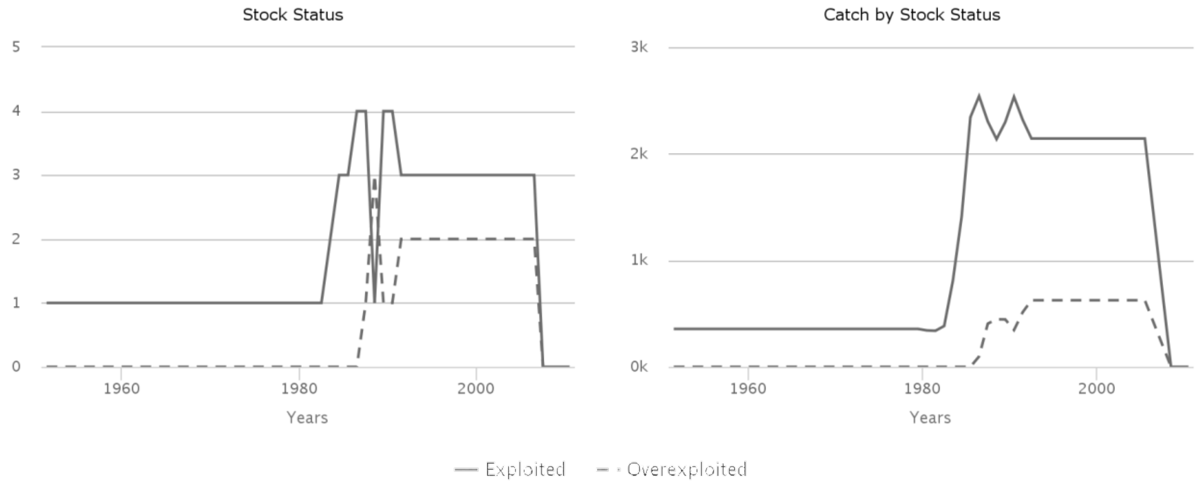
Catch value



Marine Trophic Index and Fishing-in-Balance index

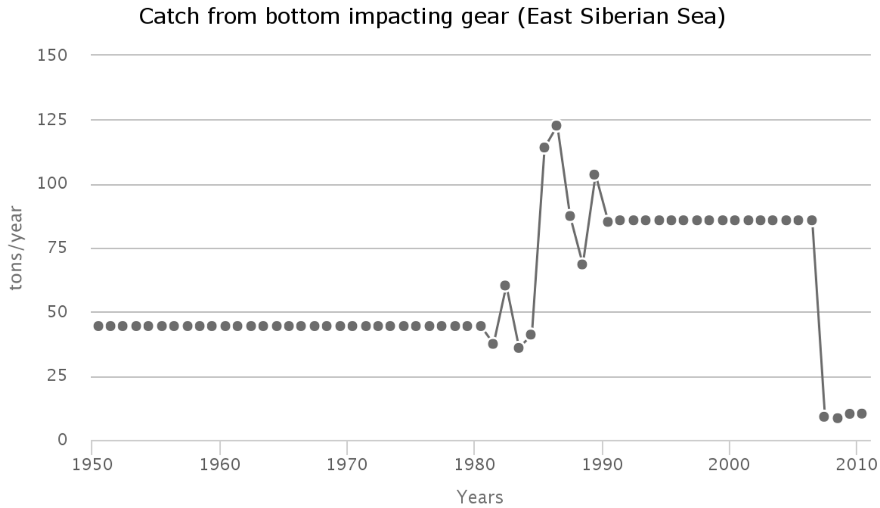
Given the very low quality of the underlying catch data, the catch-based indicators for this LME (such as PPR, MTI or FiB) are likely to be very unreliable.

Stock status



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 2 and 4% from 1950 to 2010.



Fishing effort

No effort data are available for this LME.

Primary Production Required

Given the very low quality of the underlying catch data, the catch-based indicators for this LME (such as PPR, MTI or FiB) are likely to be very unreliable.

Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering

LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.
An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a “current trends” scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	3	1	1	3	1	1	3	1

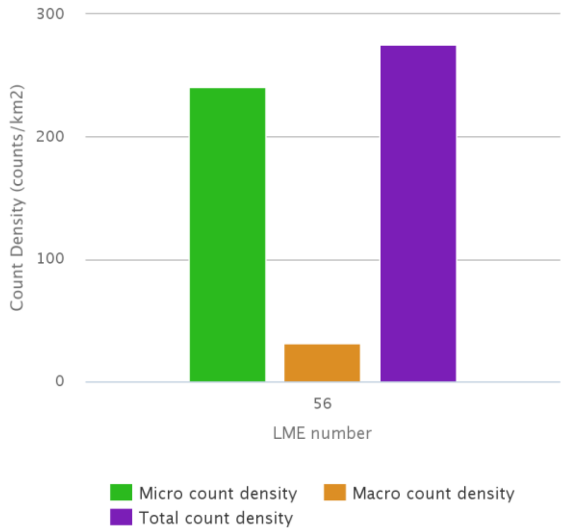
Legend: Very low, Low, Medium, High, Very high

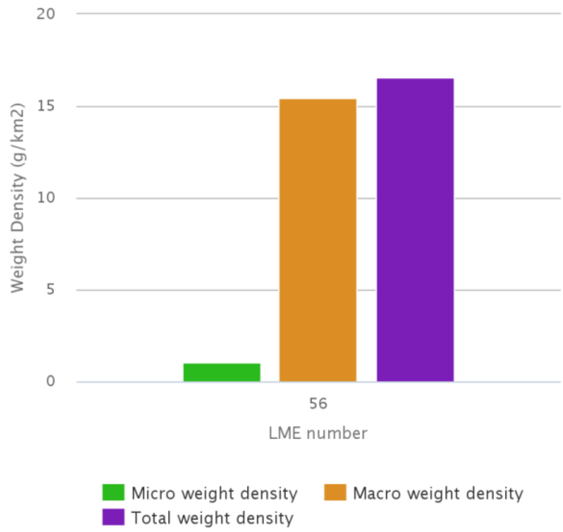
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the lowest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The low values are due to the remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be over 400 times lower than those LMEs with the highest values. There is very limited evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

Not applicable.

Reefs at risk

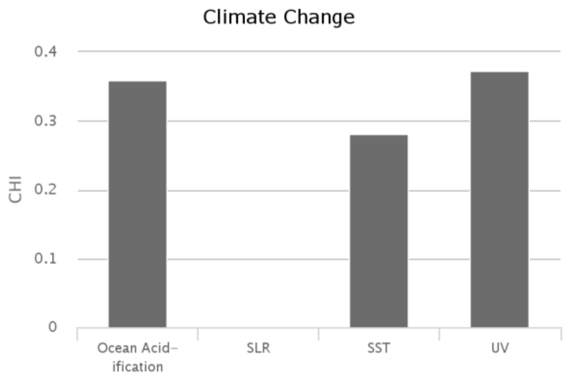
Not applicable.

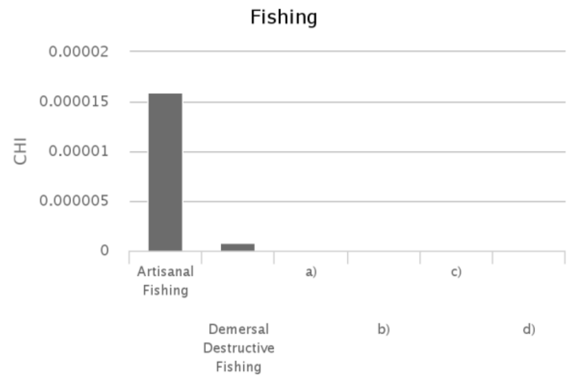
Marine Protected Area change

The East Siberian Sea LME experienced an increase in MPA coverage from 217 km^2 prior to 1983 to 3,375 km^2 by 2014. This represents an increase of 1,455%, within the low category of MPA change.

Cumulative Human Impact

The East Siberian Sea LME experiences below average overall cumulative human impact (score 1.02; maximum LME score 5.22), only a little above the LME with the least cumulative impact. It falls in risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.36; maximum in other LMEs was 1.20), UV radiation (0.37; maximum in other LMEs was 0.76), and sea surface temperature (0.28; maximum in other LMEs was 2.16). No other stressors had any significant impact in this LME.





a) Demersal Non-destructive High Bycatch Fishing
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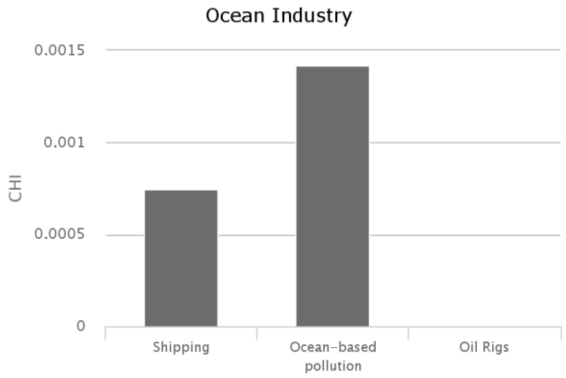
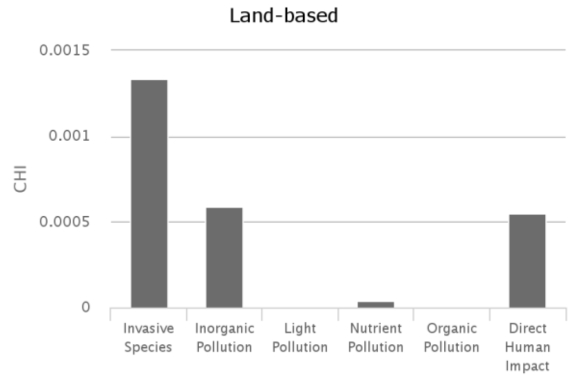
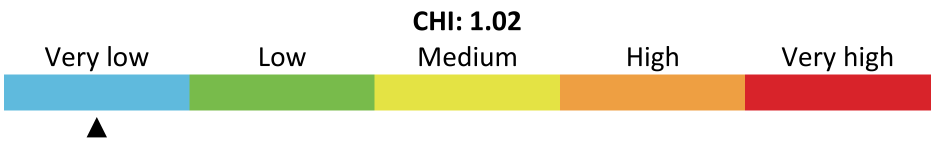
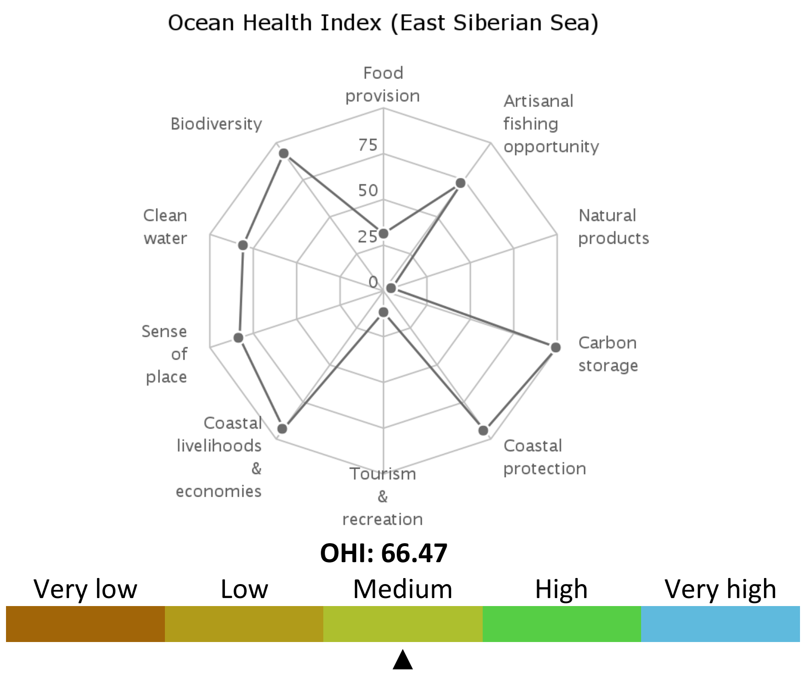






Ocean Health Index

The East Siberian Sea LME scores below average on the Ocean Health Index compared to other LMEs (score 68 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 decreased 1 point compared to the previous year, due in large part to changes in the score for clean waters. This LME scores lowest on food provision, natural products and tourism & recreation goals and highest on artisanal fishing opportunities, coastal protection, carbon storage, coastal economies, lasting special places, and habitat biodiversity goals. It falls in risk category 4 of the five risk categories, which is a relatively high level of risk (1 = lowest risk; 5 = highest risk).



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 246 312 km2. A current population of 34 thousand in 2010 is projected to decrease to 27 thousand in 2100, with a density of 14 persons per 100 km2 in 2010 decreasing to 11 per 100 km2 by 2100. About 100% of coastal population lives in rural areas, and is projected to be the same in share in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
34,151	27,383	34,151	27,382

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 12% of the LME's coastal dwellers. This LME places in the low-risk category based on percentage and in the very low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
4,172

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $1.34 million for the period 2001-2010. Fish protein accounts for 14% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$1 201 million places it in the very low-revenue category. On average, LME-based tourism income contributes 6% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with very high risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
1,344,326	14.0	1,200,951,360	6.1	0.9554

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the high HDI and low-risk category. Based on an HDI of 0.782, this LME has an HDI Gap of 0.218, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a very high-risk category (very low HDI) because of reduced income levels and population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.7818	0.8951	0.6076

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (*e.g.* overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

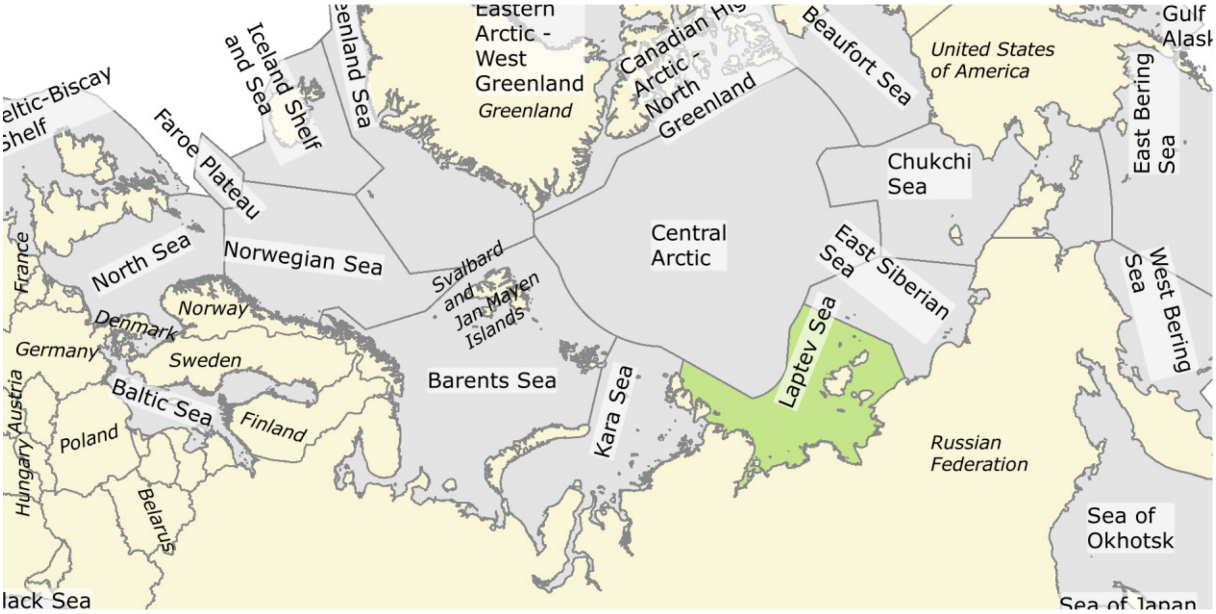
Present day climate threat index of this LME is within the medium-risk (medium threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is medium. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to low under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
0.5927	0.2994	0.2996	0.4835

Legend:

Very low Low Medium High Very high

LME 57 – Laptev Sea



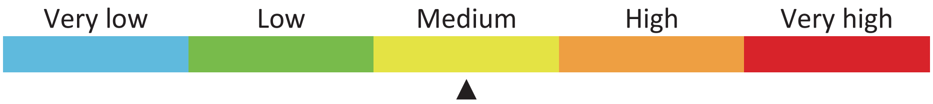
Bordering countries: Russian Federation.
LME Total area: 539,035 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit high percentages of rural coastal population, high numbers of collapsed and overexploited fish stocks, as well as high proportions of catch from bottom impacting gear.

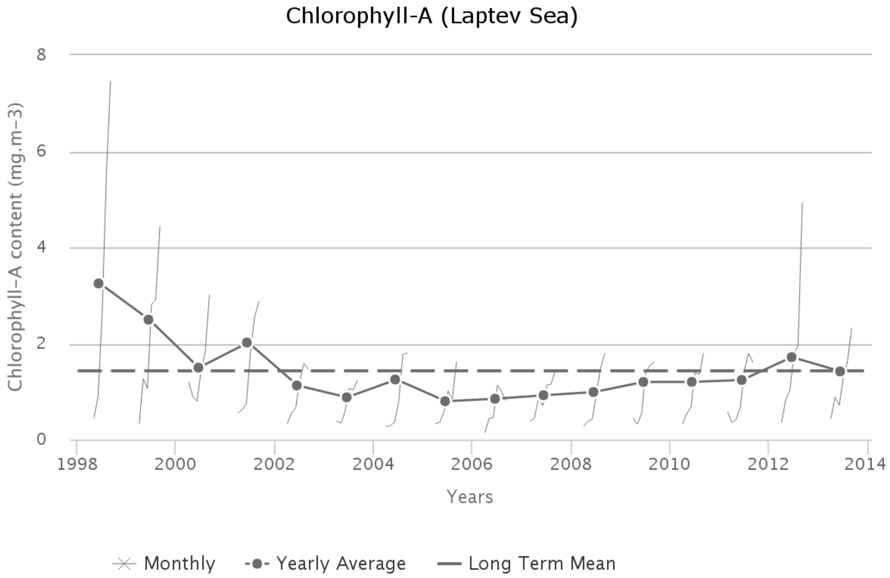
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is medium.



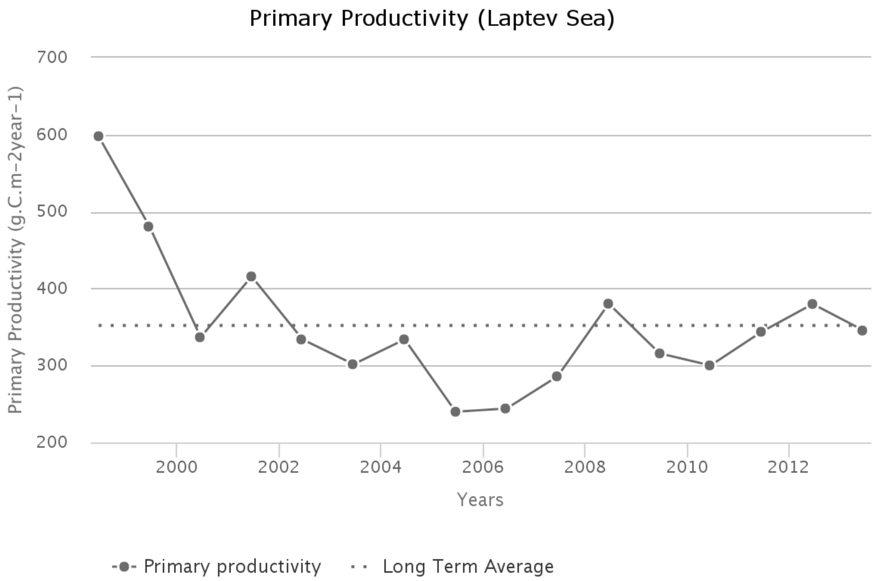
Productivity

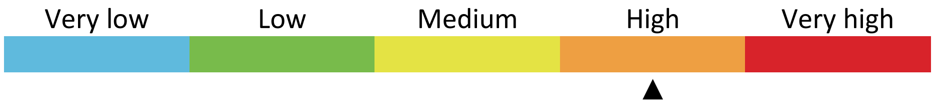
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (1.26 mg.m^{-3}) in August and a minimum (0.389 mg.m^{-3}) during April. The average CHL is 1.43 mg.m^{-3}. Maximum primary productivity (598 g.C.m^{-2}.y^{-1}) occurred during 1998 and minimum primary productivity (240 g.C.m^{-2}.y^{-1}) during 2005. There is a statistically insignificant increasing trend in Chlorophyll of 9.34 % from 2003 through 2013. The average primary productivity is 352 g.C.m^{-2}.y^{-1}, which places this LME in Group 4 of 5 categories (with 1 = lowest and 5= highest).



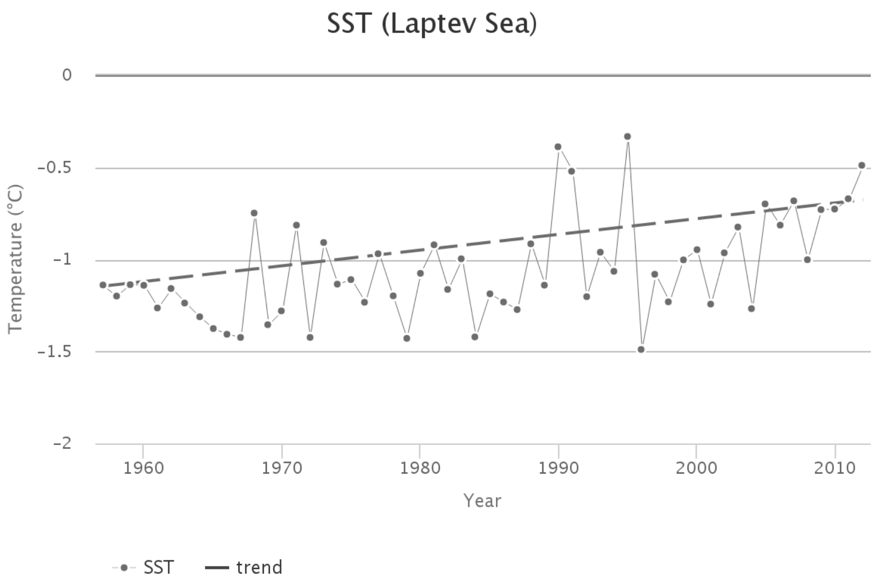
Primary productivity





Sea Surface Temperature

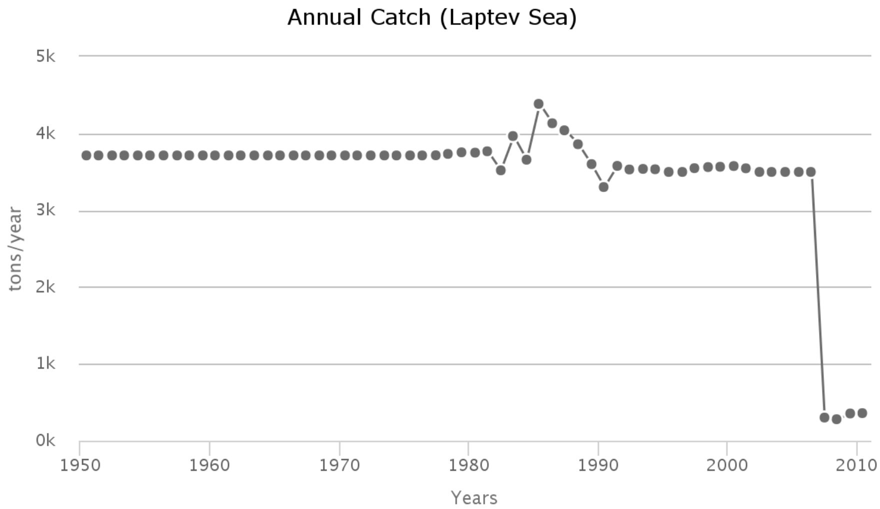
From 1957 to 2012, the Laptev Sea LME #57 has warmed by 0.47°C, thus belonging to Category 3 (moderate warming LME). The Laptev Sea's steady warming was modulated by strong interannual variability. The largest interannual variability was observed between the all-time maximum of >-0.4°C in 1995 and the all-time minimum of -1.5°C in 1996. The peak of 1995 occurred simultaneously in the adjacent Kara Sea; it was not observed elsewhere. Therefore, the 1995 warm event was confined to just two contiguous LMEs, Laptev and Kara Seas. The warm episode of the late 1980s-early 1990s was positively correlated with the Arctic Oscillation index. Similar the East Siberian Sea LME #54, the Laptev Sea LME #55 experienced a regime shift from a cold epoch in 1957-1996 to a warm epoch afterwards. During the warm epoch, SST rose from -1.5°C in 1996 to -0.5°C in 2012.



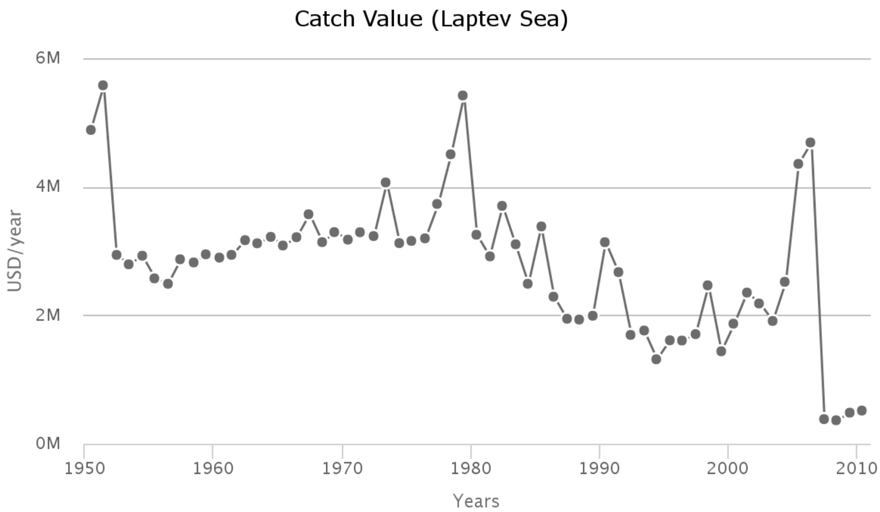
Fish and Fisheries

The fish fauna of the Laptev Sea is extremely impoverished, as it is remote from both the Barents Sea to the west and Bering Sea to the east. As in the neighboring Kara and East Siberian seas, whitefish species (*genus Coregonus*), or "sig" in Russian, form the bulk of the fisheries catch in this LME, but detailed records are available only from the lower reaches of the Lena and Yana rivers, and from Khatanga Bay for the years 1981 to 1991. These catches, amounting to about 4,300 t per year on average, do not show any consistent trend, unlike those from the Kara Sea. In the absence of other data which may support an alternative estimation procedure, these data were extrapolated both backward to 1950, and forward to 2010. The catch data from this LME are too crude for ecosystem indicators such as PPR, MTI or FiB index to be computed.

Annual Catch



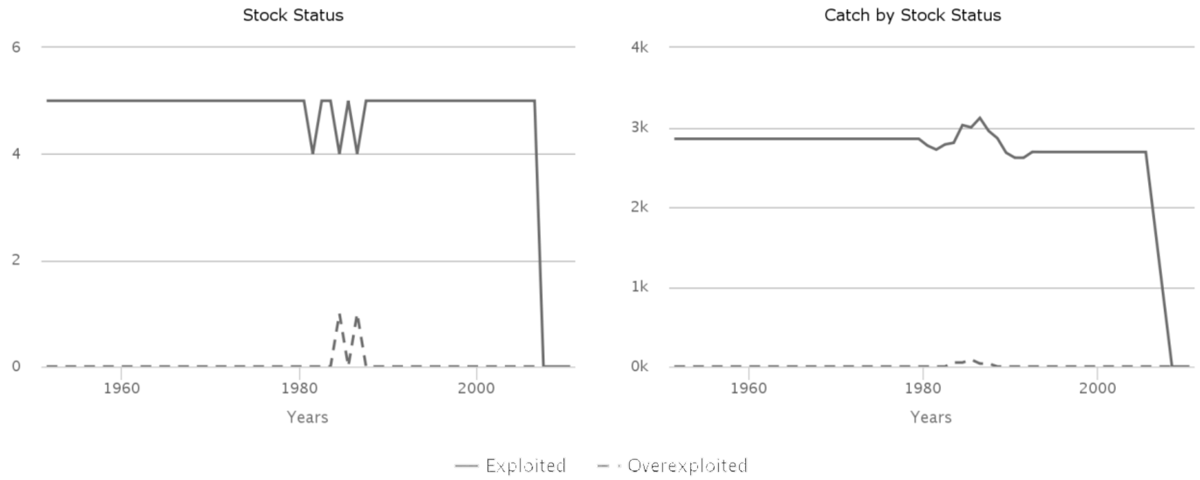
Catch value



Marine Trophic Index and Fishing-in-Balance index

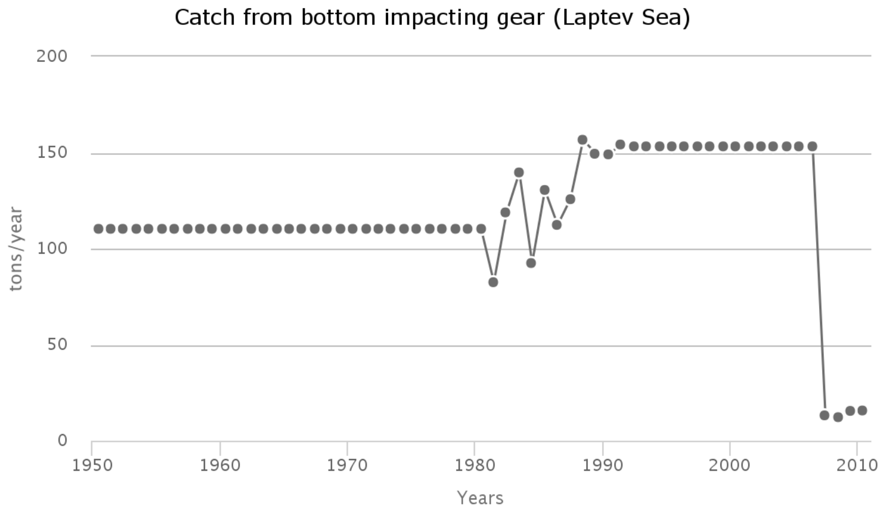
Given the very low quality of the underlying catch data, the catch-based indicators for this LME (such as PPR, MTI or FiB) are likely to be very unreliable.

Stock status



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 3 and 5% from 1950 to 2010.



Fishing effort

No effort data are available for this LME.

Primary Production Required

Given the very low quality of the underlying catch data, the catch-based indicators for this LME (such as PPR, MTI or FiB) are likely to be very unreliable.

Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of

shellfish, etc.) on ecosystems and humans.
An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	3	1	1	3	1	1	3	1

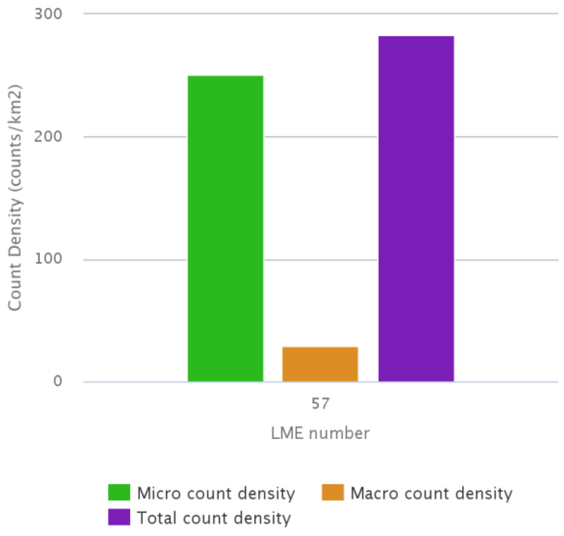
Legend:
Very low Low Medium High Very high

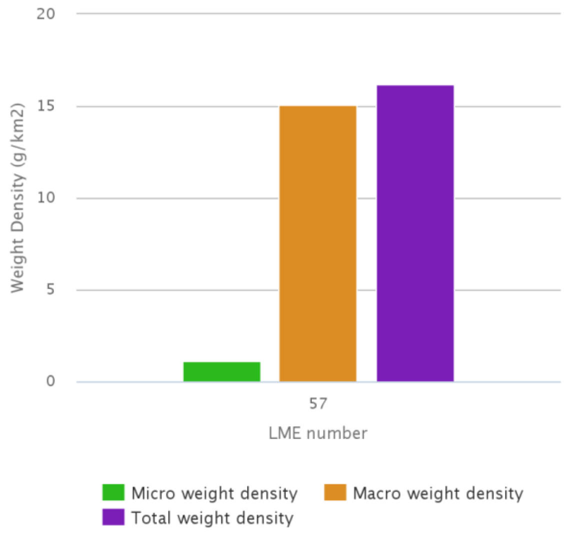
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the lowest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The low values are due to the remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be over 400 times lower than those LMEs with the highest values. There is very limited evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

Not applicable.

Reefs at risk

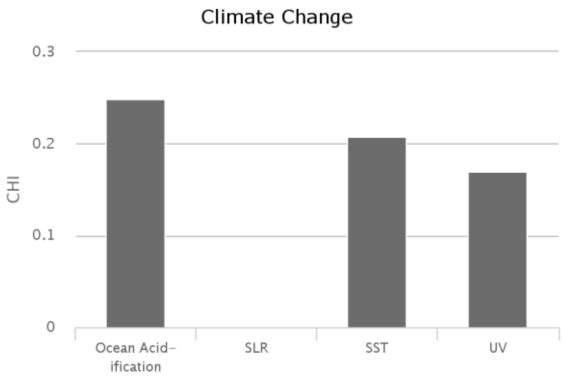
Not applicable.

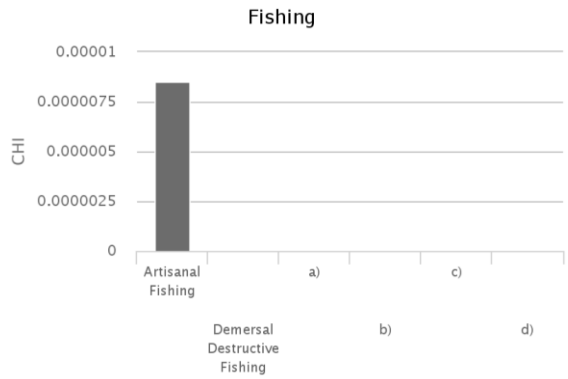
Marine Protected Area change

The Laptev Sea LME experienced an increase in MPA coverage from 1,955 km^2 prior to 1983 to 34,216 km^2 by 2014. This represents an increase of 1,650%, within the low category of MPA change.

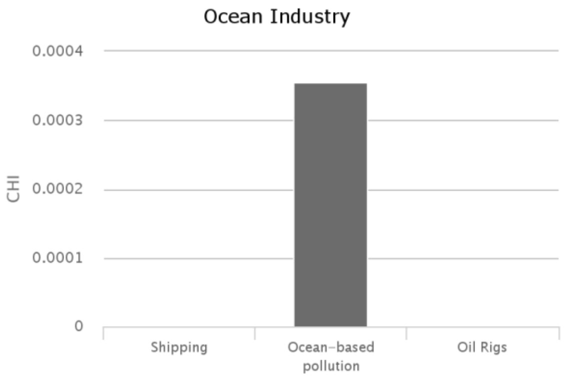
Cumulative Human Impact

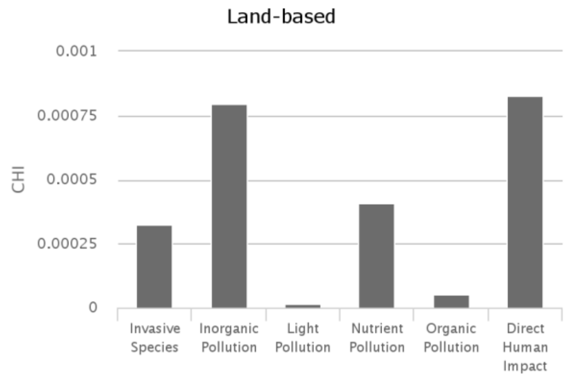
The Laptev Sea LME experiences one of the lowest overall cumulative human impact (score 0.63; maximum LME score 5.22). It falls in risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.25; maximum in other LMEs was 1.20), UV radiation (0.17; maximum in other LMEs was 0.76), and sea surface temperature (0.21; maximum in other LMEs was 2.16). No other stressors had any significant impact in this LME.

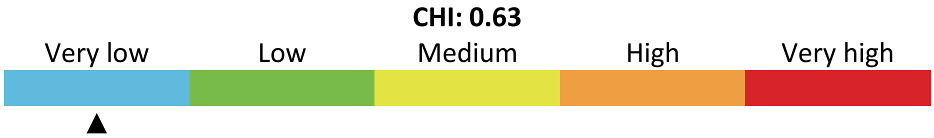




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

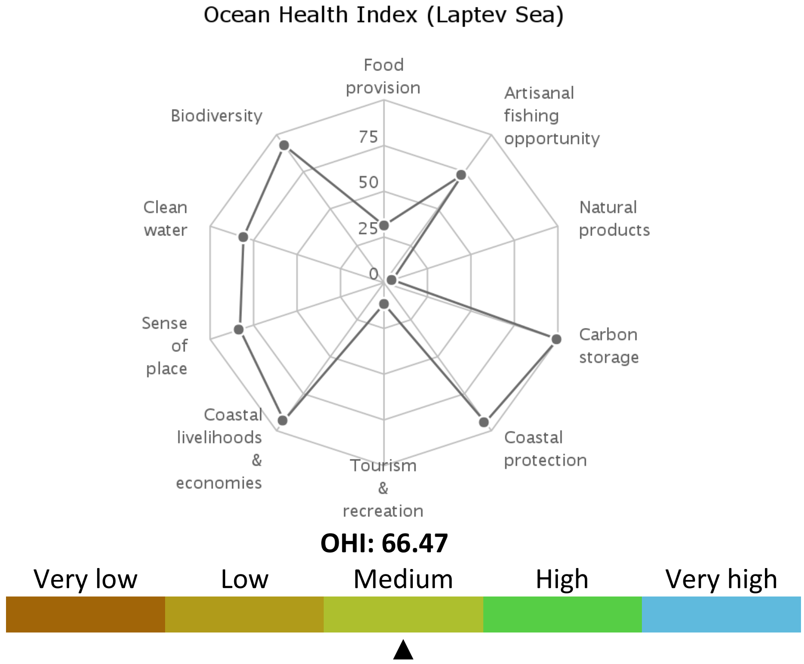






Ocean Health Index

The Laptev ring Sea LME scores below average on the Ocean Health Index compared to other LMEs (score 68 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 decreased 1 point compared to the previous year, due in large part to changes in the score for clean waters. This LME scores lowest on food provision, natural products, and tourism & recreation goals and highest on artisanal fishing opportunities, coastal protection, carbon storage, coastal economies, lasting special places and habitat biodiversity goals. It falls in risk category 4 of the five risk categories, which is a relatively high level of risk (1 = lowest risk; 5 = highest risk).



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 616 280 km^2. A current population of 31 thousand in 2010 is projected to increase to 38 thousand in 2100, with a density of 5 persons per 100 km^2 in 2010 increasing to 6 per 100 km^2 by 2100. About 100% of coastal population lives in rural areas, and is projected to be the same in share in 2100.

Total population		Rural population	
2010	2100	2010	2100
31,013	37,888	31,012	37,887

Legend:

Very low Low Medium High Very high

Coastal poor

The indigent population makes up 12% of the LME's coastal dwellers. This LME places in the low-risk category based on percentage and in the very low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
3,789

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $3 million for the period 2001-2010. Fish protein accounts for 14% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013 $3 781 million places it in the very low-revenue category. On average, LME-based tourism income contributes 6% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with high risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
2,989,354	14.0	3,780,772,800	6.1	0.8232

Legend: Very low | Low | Medium | High | Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the high HDI and low-risk category. Based on an HDI of 0.782, this LME has an HDI Gap of 0.218, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a very high-risk category (very low HDI) because of reduced income levels and increased population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.7818	0.8951	0.6076

Legend: Very low | Low | Medium | High | Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

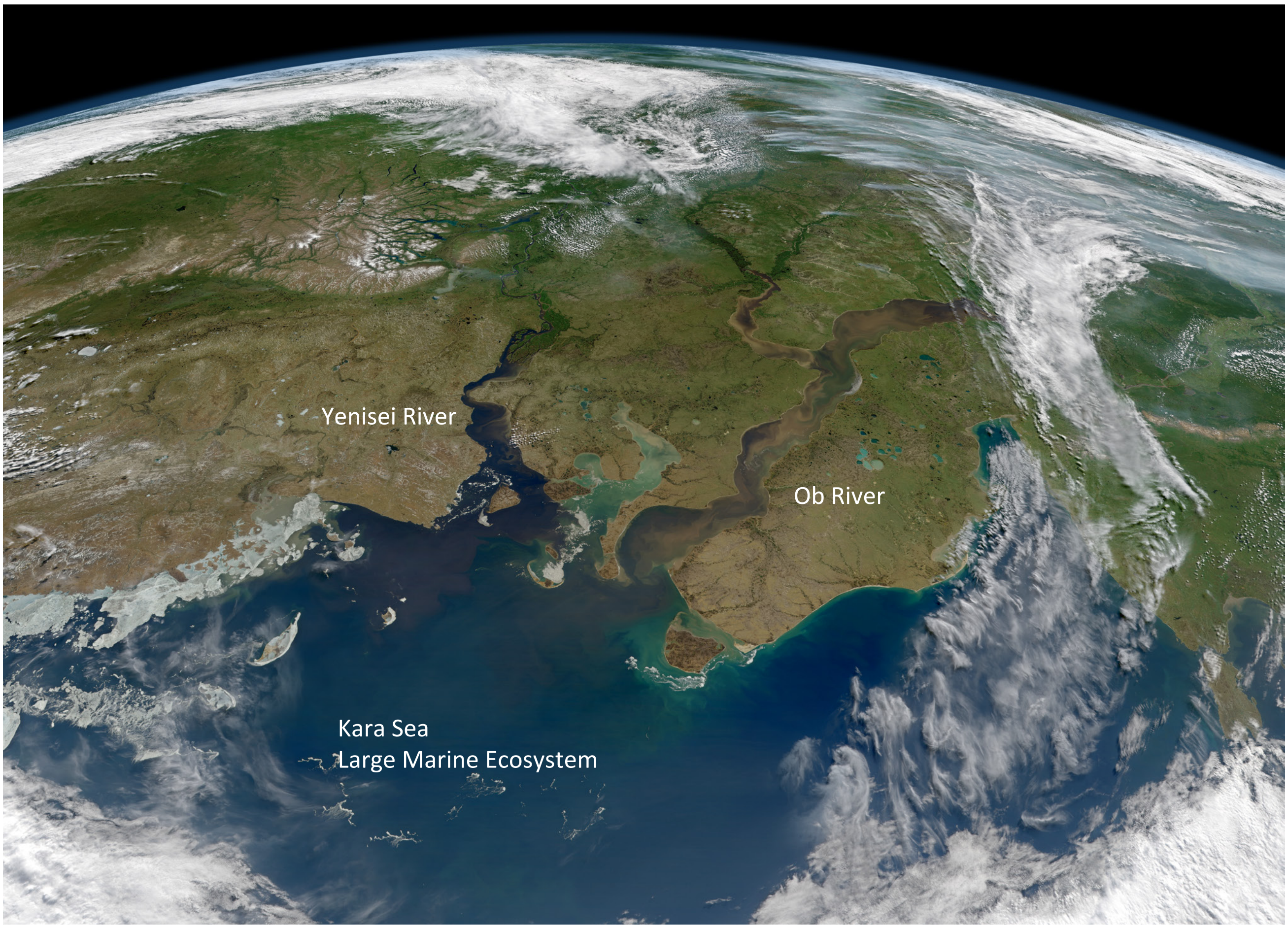
The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the medium-risk (medium threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is low. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to low under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.5903	0.2967	0.3137	0.5046

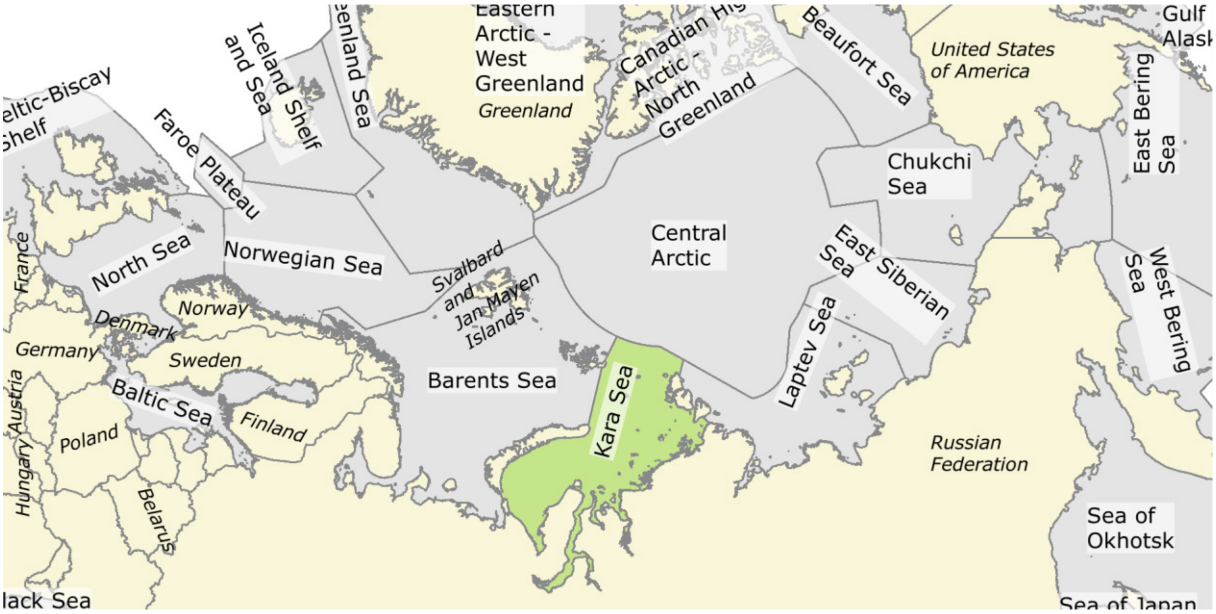
Legend:

Very low | Low | Medium | High | Very high



NASA Earth Observatory

LME 58 – Kara Sea



Bordering countries: Russian Federation.
LME Total area: 970,089 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit a significant influence of capacity-enhancing fisheries subsidies.

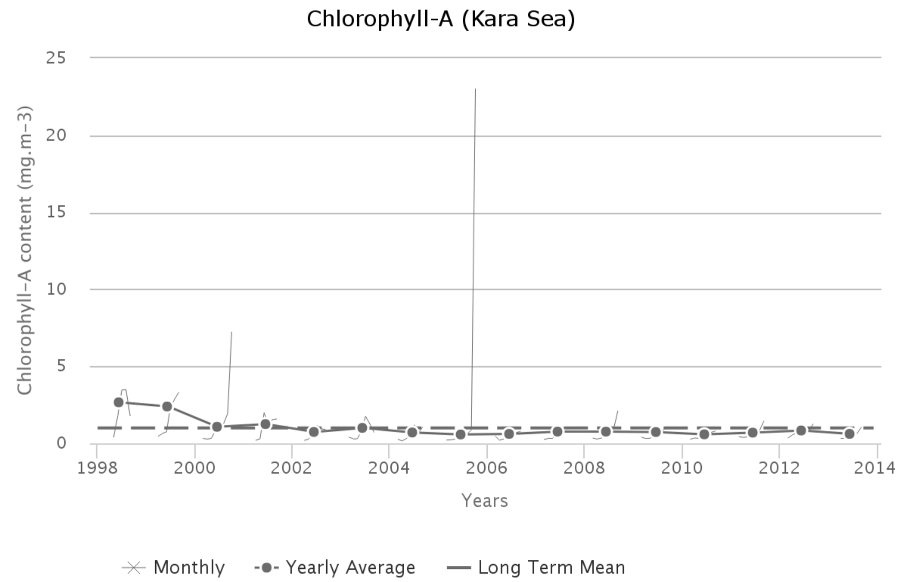
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is high.

Very low Low Medium High Very high

Productivity

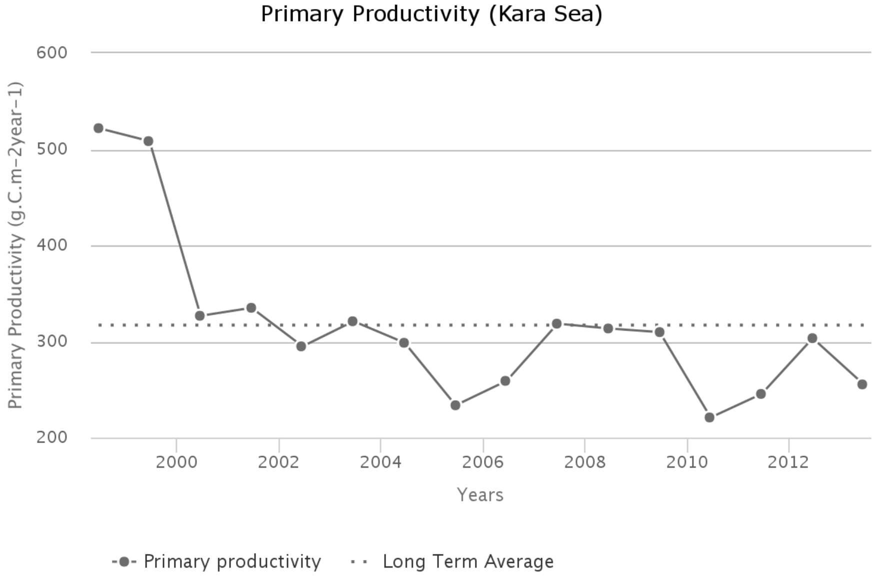
Chlorophyll-A

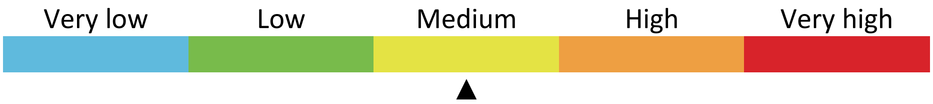
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (14.2 $mg.m^{-3}$) in October and a minimum (0.325 $mg.m^{-3}$) during April. The average CHL is 0.998 $mg.m^{-3}$. Maximum primary productivity (522 $g.C.m^{-2}.y^{-1}$) occurred during 1998 and minimum primary productivity (221 $g.C.m^{-2}.y^{-1}$) during 2010. There is a statistically insignificant decreasing trend in Chlorophyll of -44.5 % from 2003 through 2013. The average primary productivity is 317 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).



Very low Low Medium High Very high

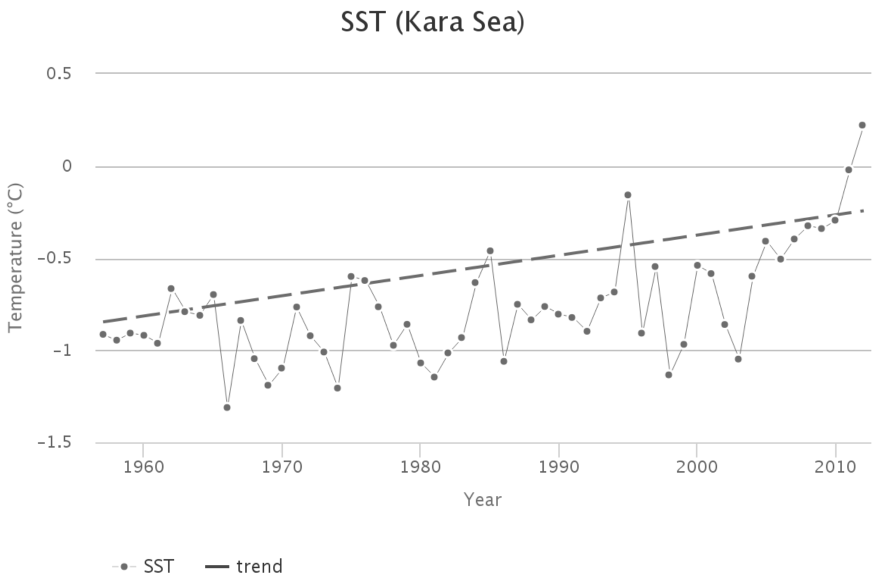
Primary productivity





Sea Surface Temperature

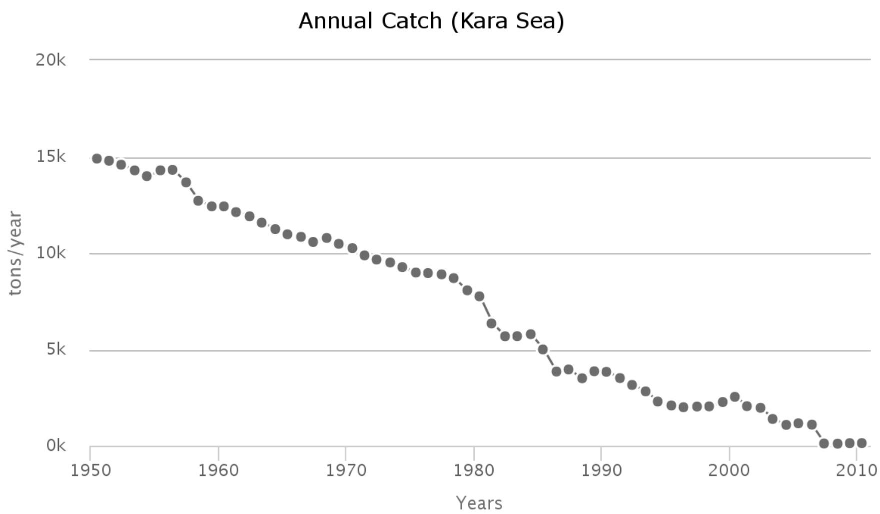
From 1957 to 2012, the Kara Sea LME #58 has warmed by 0.60°C, thus belonging to Category 3 (moderate warming LME). The Kara Sea warming was accentuated by a single event, the 1995 maximum, which occurred concurrently in the Laptev Sea. Interannual variability was moderate, with a magnitude of 0.5°C, similar to the Laptev Sea. The thermal history of the Kara Sea is negatively correlated with the Arctic Oscillation (AO) index. In this respect, the Kara Sea is similar to the Beaufort Sea LME #55. At the same time, the Kara Sea SST appears to be decorrelated from the adjacent Laptev Sea LME #57's SST since the latter is negatively correlated with the AO index. This pattern can be explained by the lack of oceanographic connection between the Kara and Laptev seas. Indeed, the only significant connection between these seas is through the shallow Vilkitsky Strait, which is covered with sea ice year-round. The very fast warming from <-1.0°C in 2004 to 0.2°C in 2012, at a rate of >1.2°C in 8 years, is unprecedented for the Arctic Ocean marginal seas. The rate of this most recent warming is among the fastest decadal warming rates observed in the World Ocean.



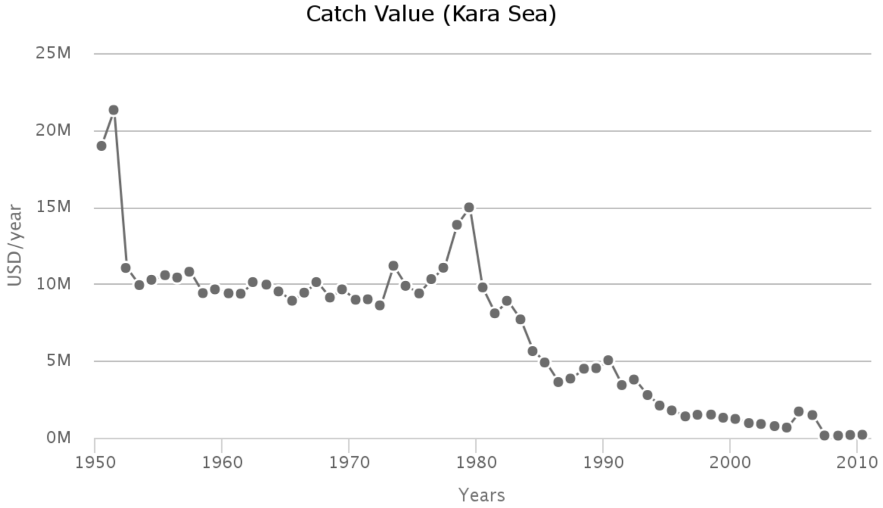
Fish and Fisheries

The Kara Sea benefits from the occasional intrusion of "warm" water, with accompanying fauna. However, except for these occasional strays, the fish fauna of the Kara Sea is species poor with the bulk of the fisheries catches contributed by the genus *Coregonus*, (Subfamily *Coregoninae*, Family *Salmonidae*) known as "whitefishes" or "sig" in Russian. Six of their species make up about 80% of the total fisheries landing in the LME. Their declining catches are explained in part by extreme pollution of the estuaries and coastal areas and by overfishing.

Annual Catch



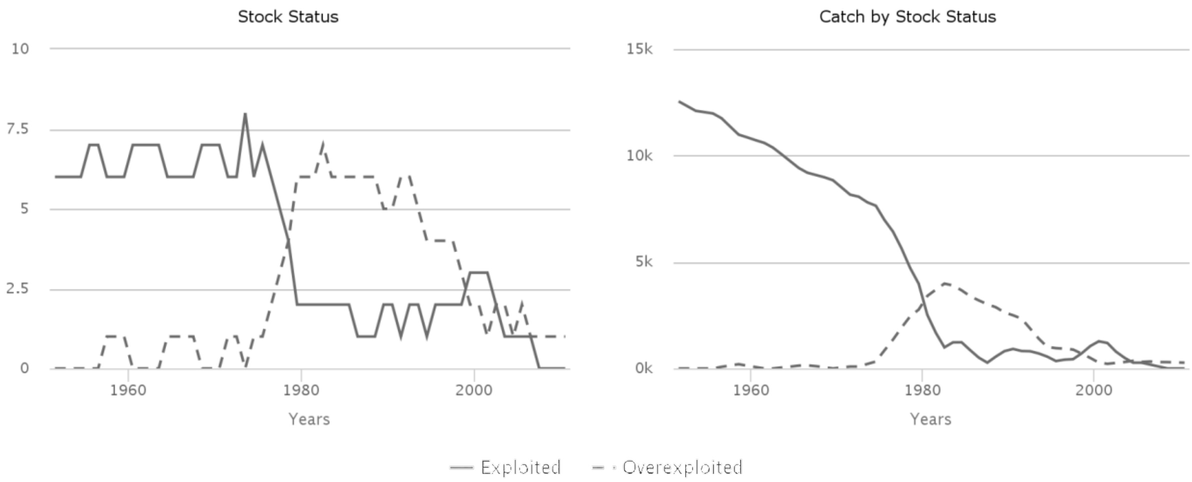
Catch value



Marine Trophic Index and Fishing-in-Balance index

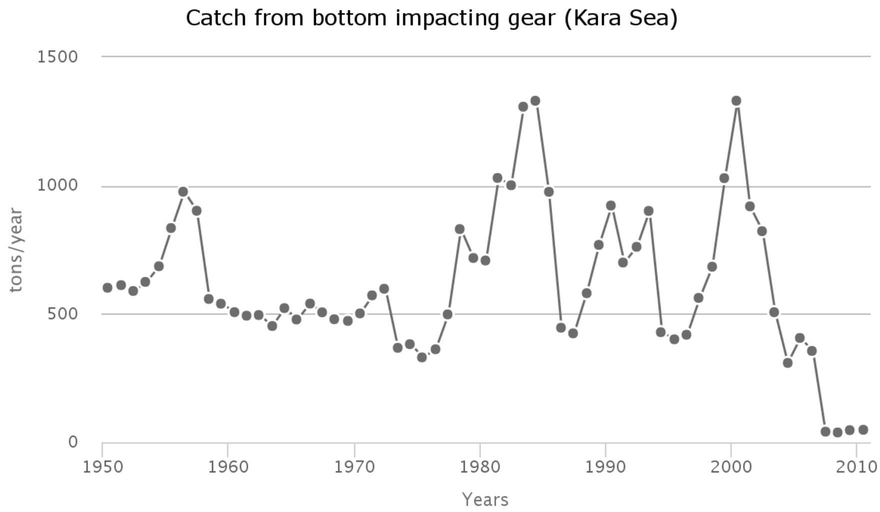
Given the very low quality of the underlying catch data, the catch-based indicators for this LME (such as PPR, MTI or FiB) are likely to be very unreliable.

Stock status



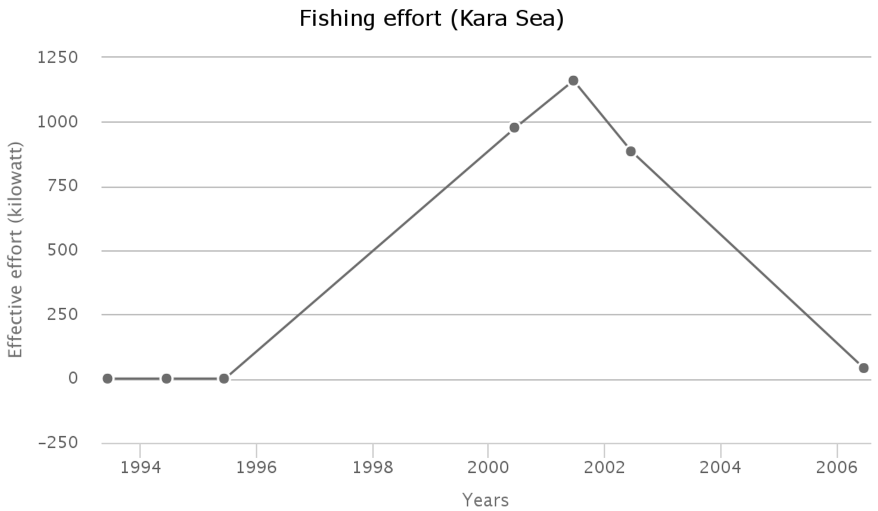
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch increased from 5% in the early 1950s to the peak at around 52% in 1999.



Fishing effort

Then, this percentage fluctuated around 36% in recent decade. The whole time series data of fishing effort in this region is not available.



Primary Production Required

Given the very low quality of the underlying catch data, the catch-based indicators for this LME (such as PPR, MTI or FiB) are likely to be very unreliable.

Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.

An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was low (level 2 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this increased to moderate in 2030 and remained moderate in 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this increased to moderate in 2030 and remained the same in 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
2	3	2	3	3	3	3	3	3

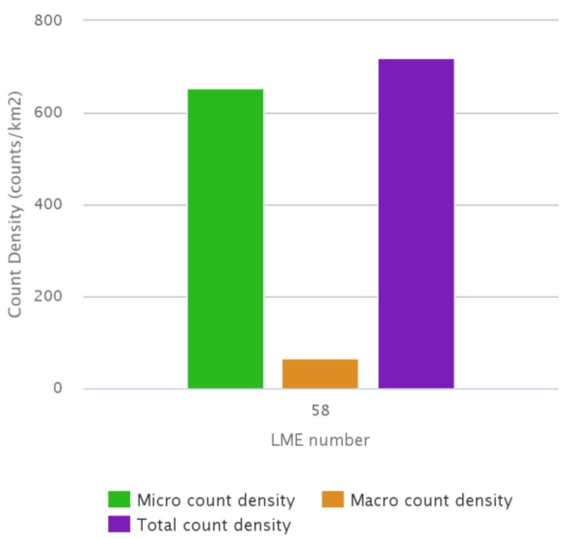
Legend: Very low, Low, Medium, High, Very high

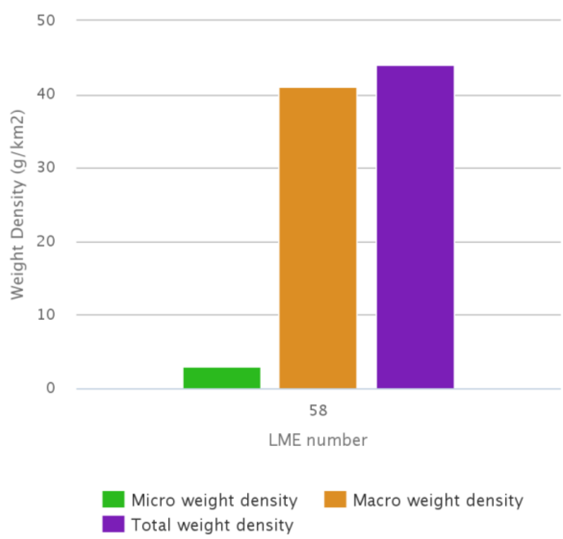
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively low levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The low values are due to the relative remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be on average over 40 times lower that those LMEs with the highest values. There is very limited evidence from sea-based direct observations and towed nets to support this conclusion.





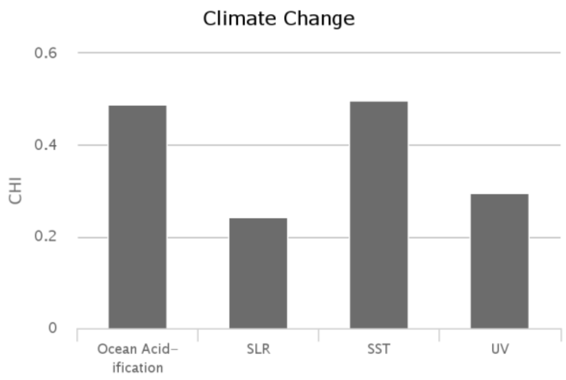
Ecosystem Health

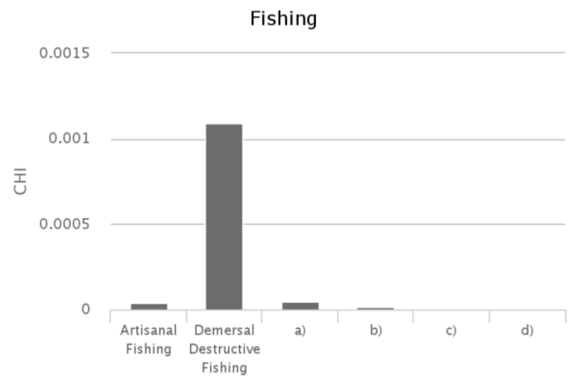
Mangrove and coral cover
Not applicable.

Reefs at risk
Not applicable.

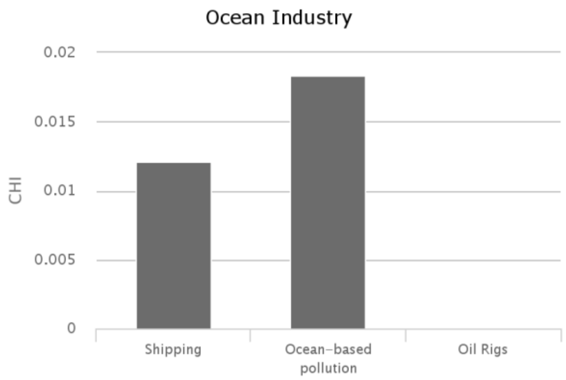
Marine Protected Area change
The Kara Sea LME experienced an increase in MPA coverage from 3,799 km^2 prior to 1983 to 41,102 km^2 by 2014. This represents an increase of 982%, within the low category of MPA change.

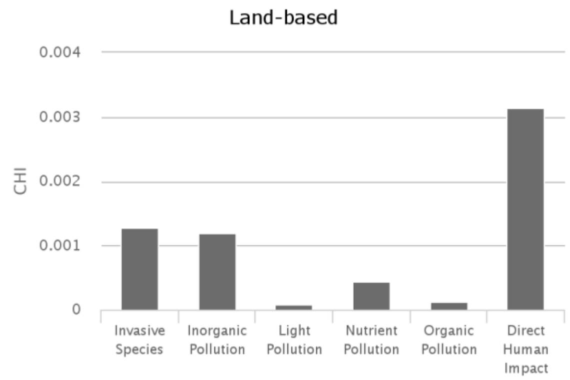
Cumulative Human Impact
The Kara Sea LME experiences below average overall cumulative human impact (score 1.56; maximum LME score 5.22), but which is still above the LME with the least cumulative impact. It falls in risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, all four connected to climate change have the highest average impact on the LME: ocean acidification (0.49; maximum in other LMEs was 1.20), UV radiation (0.30; maximum in other LMEs was 0.76), sea level rise (0.24; maximum in other LMEs was 0.71), and sea surface temperature (0.50; maximum in other LMEs was 2.16). No other stressors had any significant impact in this LME.

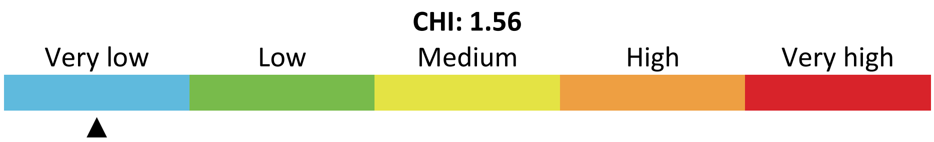




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

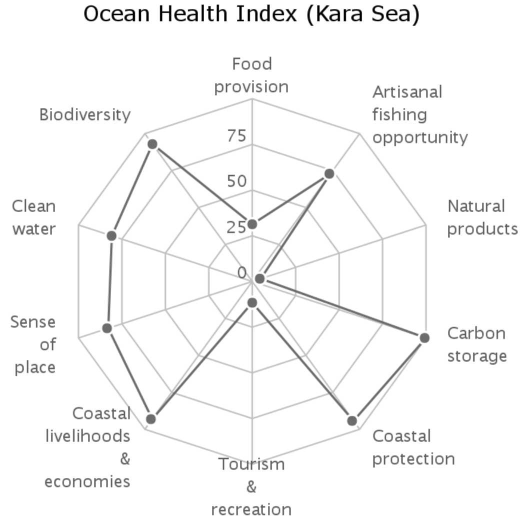


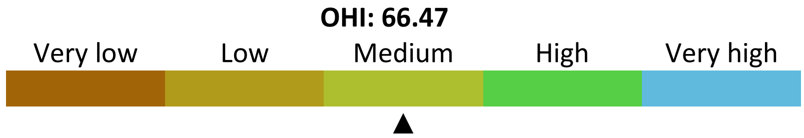




Ocean Health Index

The Kara Sea LME scores below average on the Ocean Health Index compared to other LMEs (score 68 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 decreased 1 point compared to the previous year, due in large part to changes in the score for natural products. This LME scores lowest on food provision, natural products, and tourism & recreation goals and highest on artisanal fishing opportunities, coastal protection, carbon storage, coastal economies, lasting special places and habitat biodiversity goals. It falls in risk category 4 of the five risk categories, which is a relatively high level of risk (1 = lowest risk; 5 = highest risk).





Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 675 511 km^2. A current population of 277 thousand in 2010 is projected to decrease to 135 thousand in 2100, with a density of 41 persons per 100 km^2 in 2010 increasing to 20 per 100 km^2 by 2100. About 40% of coastal population lives in rural areas, and is projected to be increase in share to 53% in 2100.

Total population		Rural population	
2010	2100	2010	2100
276,868	135,355	111,075	72,105

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 12% of the LME's coastal dwellers. This LME places in the low-risk category based on percentage and in the low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
33,824

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $0.83 million for the period 2001-2010. Fish protein accounts for 14% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013 $5 126 million places it in the low-revenue category. On average, LME-based tourism income contributes 6% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with high risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
826,300	14.0	5,126,283,120	6.1	0.8522

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the high HDI and low-risk category. Based on an HDI of 0.782, this LME has an HDI Gap of 0.218, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a very high-risk category (very low HDI) because of reduced income levels and population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.7818	0.8951	0.6076

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).
The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.
Present day climate threat index of this LME is within the high-risk (high threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is medium. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to low under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.6401	0.3360	0.3034	0.4828

Legend:

Very low Low Medium High Very high

LME 62 – Black Sea

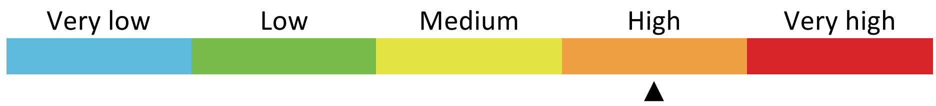
Bordering countries: Turkey, Bulgaria, Romania, Ukraine, Russian Federation, Georgia.
LME Total area: 461398 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit low to medium levels of economic development (based on the night light development index) and medium levels of collapsed and overexploited fish stocks.

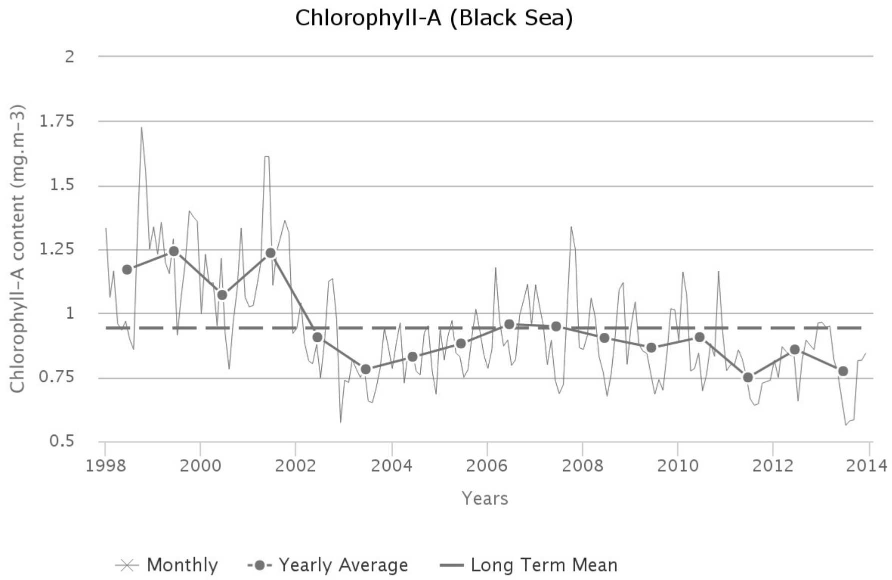
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is high..

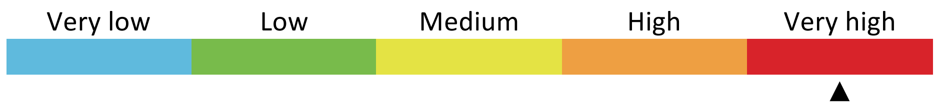


Productivity

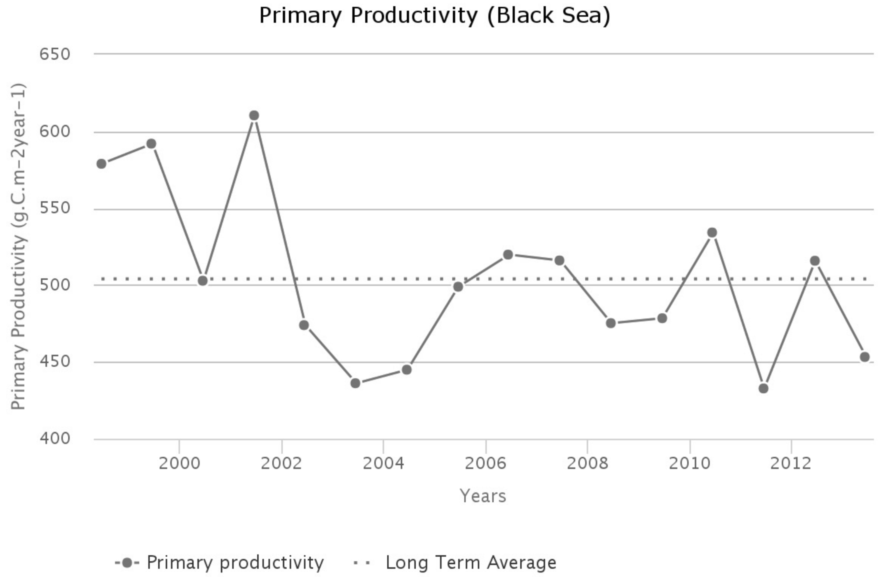
Chlorophyll-A

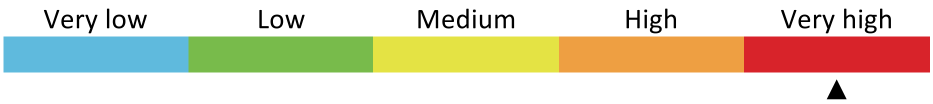
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (1.10 mg.m^{3}) in November and a minimum (0.757 mg.m^{3}) during July. The average CHL is 0.942 mg.m^{3}. Maximum primary productivity (610 g.C.m^{2}.y^{1}) occurred during 2001 and minimum primary productivity (433 g.C.m^{2}.y^{1}) during 2011. There is a statistically insignificant decreasing trend in Chlorophyll of 5.30 % from 2003 through 2013. The average primary productivity is 504 g.C.m^{2}.y^{1}, which places this LME in Group 5 of 5 categories (with 1 = lowest and 5= highest).





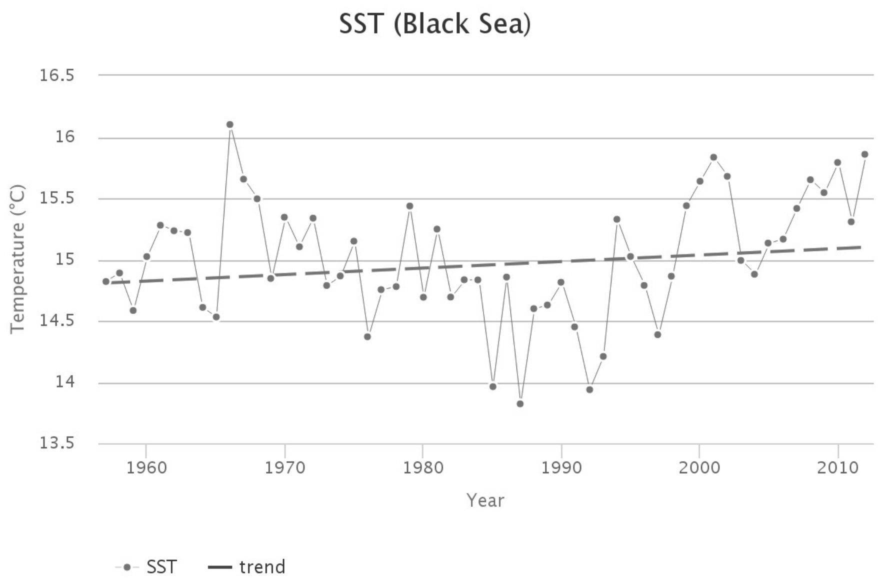
Primary productivity





Sea Surface Temperature

From 1957 to 2012, he lack Sea LME #62 has armed y 31°C, hus elonging o ategory 4 (slow warming LME). After peaking in 1966 at 16.1°C, SST dropped down to 14.0°C in 1987, an exceptionally cold year in this region. Thus, SST decreased by 2.1°C in 21 years between 1966 and 1987, after which SST rose to 15.8°C in 2001 and remained relatively high through 2012. Yet the long term linear trend based warming between 1957 and 2012 was just 0.31°C due to the pronounced cooling of the 1980s 1990s. These numbers compare favorably with those by Ginzburg et al. (2008) who studied seasonal and interannual variability from satellite SST in 1982 2002 and reported the same cold events of 1985, 1987, and 1992 1993 that are evident above; they also found out that winter SST has bottomed out in early 1993 and reported a 3°C increase in summer SST (from 23°C to 26°C) in 1982 2002, with the summertime SST trend being mostly decoupled from the wintertime SST trends except for the last few years. The extreme magnitude of the 1982 2002 trend reported by Ginzburg et al. (2008) is not corroborated by our data.

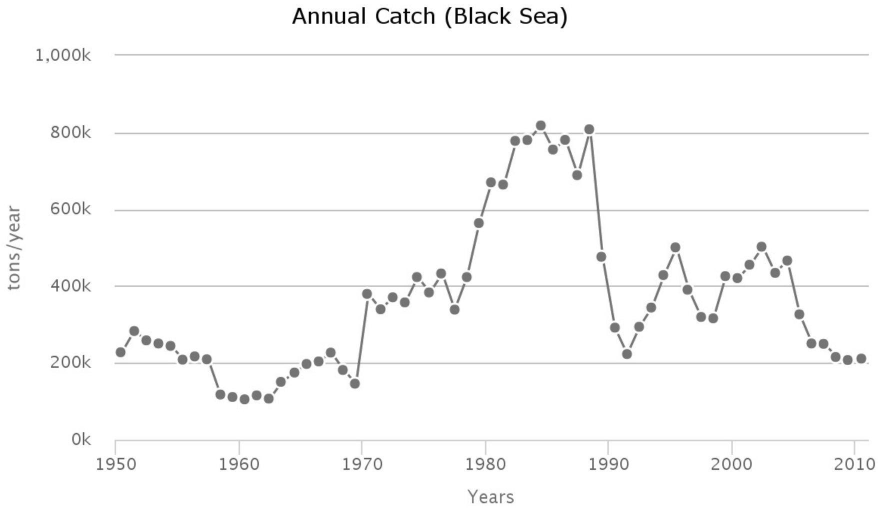


Fish and Fisheries

Marine fisheries are an important economic sector in the countries bordering the Black Sea LME, and virtually all its commercial fish stocks are shared among the bordering countries. In addition to capture fisheries, there is a long history of sturgeon aquaculture in the Azov Sea and more recently, the cultivation of mussels, oysters, shrimp and some finfish. Prior to the 1970s, there were abundant stocks of several valuable species in the LME.

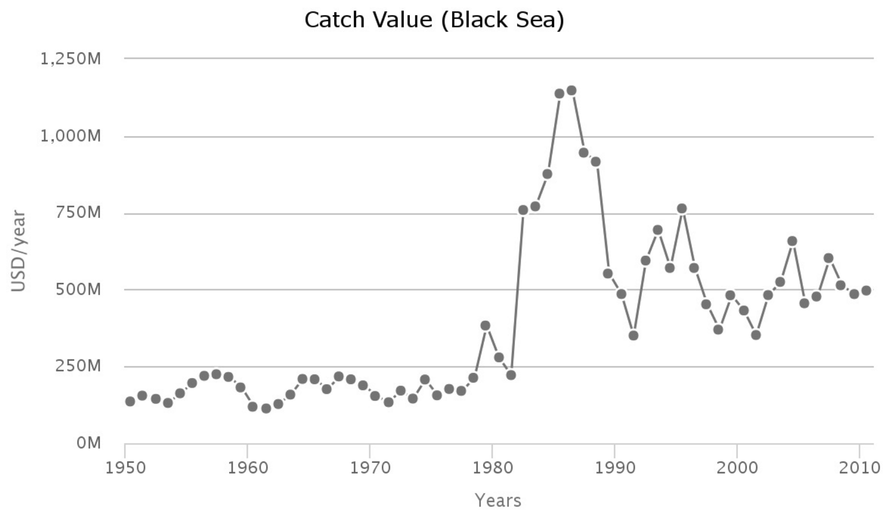
Annual Catch

Total reported landings in this LME showed several peaks and troughs, driven primarily by the fluctuation in the landings of European anchovy, with a peak landing of 820,000 t recorded in 1984. The landings have increased following a precipitous decline from 1989 to 1991, however, they have not returned to the level achieved in the mid 1980s.



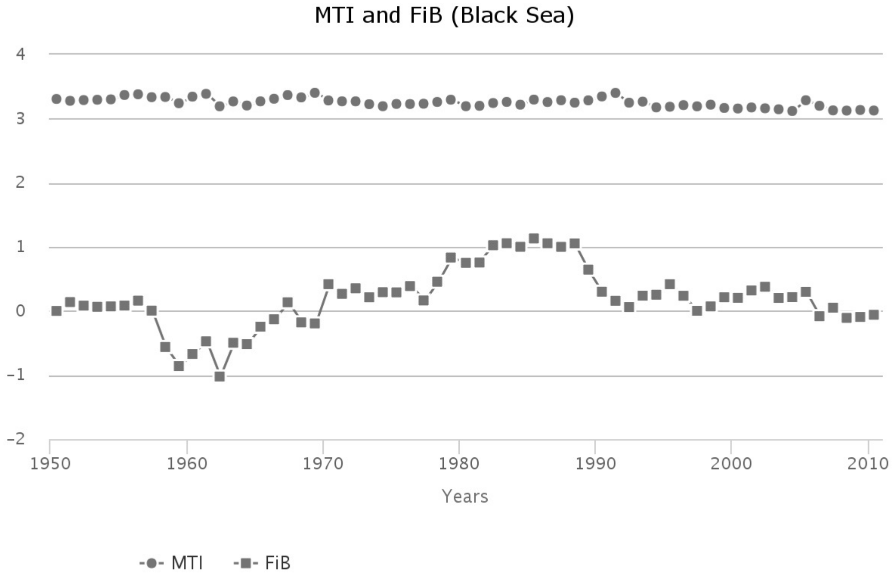
Catch value

The value of the reported landings reflected the trend in the landings, peaking in 1986 at about 1.1 billion US$ (in 2005 real US$).



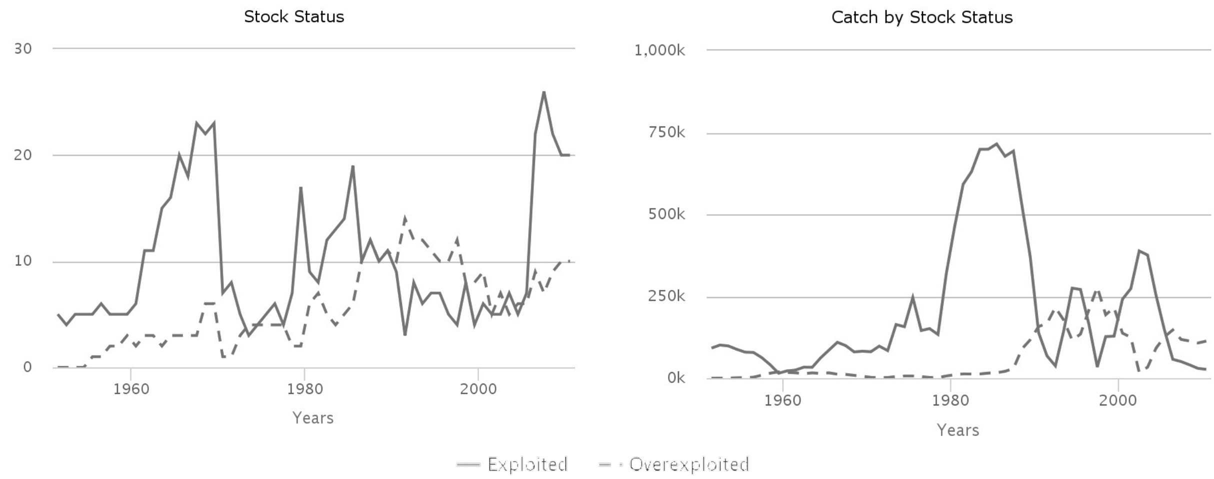
Marine Trophic Index and Fishing-in-Balance index

The MTI has been on a decline since the 1950s, with very low values being observed in the 1990s. The increase in the FiB index from the 1970s to the mid 1980s is driven by the increased reported landings of anchovy during this period. The FiB index declined in the early 1990s, an indication of ‘fishing own’ f he ood eb n his ME.



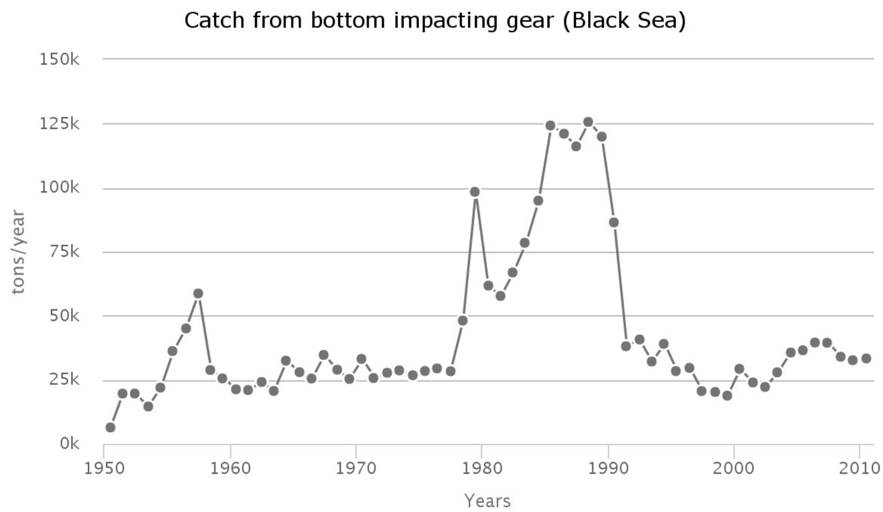
Stock status

The Stock Catch Status Plots indicate a high level of collapsed stocks (about 30%) which contribute less than 10% of the total catch, with close to 60% of the reported landings coming from overexploited stocks.



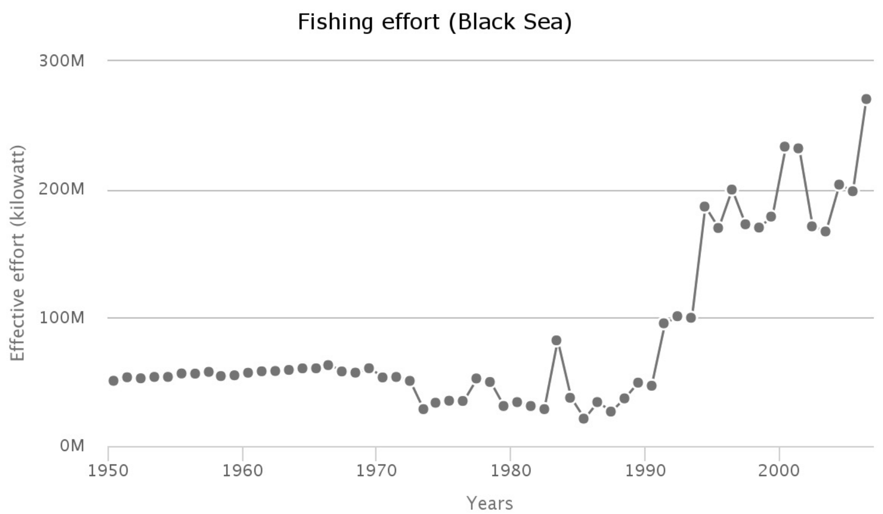
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 2 and 30% from 1950 to 2010. This percentage fluctuated between 4 and 16% in the recent decade.

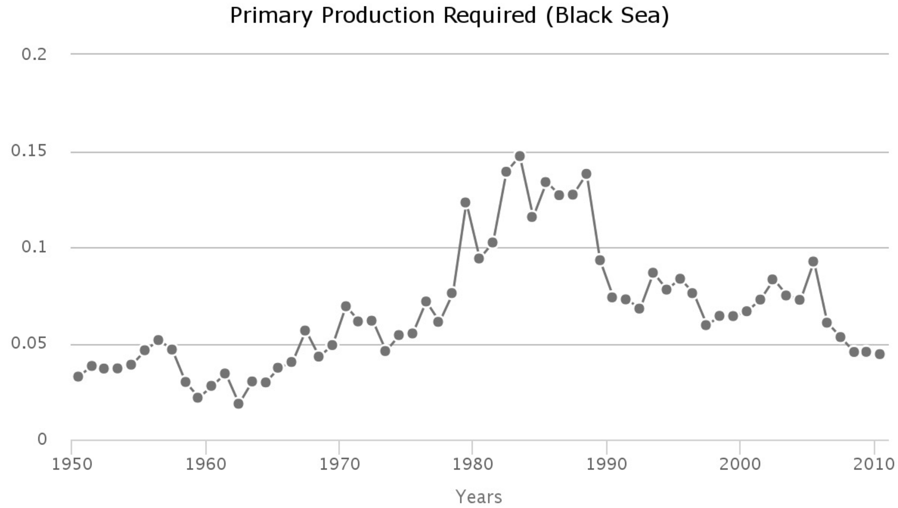


Fishing effort

The total effective effort continuously increased from around 50 million kW in 1950 to its peak around 270 million kW in 2006.



Primary Production Required



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.
An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was moderate (level 3 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was high (4). According to the Global Orchestration scenario, his emained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was high (4). According to the Global Orchestration scenario, his emained he ame n 030 nd 050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
3	4	4	3	4	4	3	4	4

Legend:
Very low Low Medium High Very high

POPs

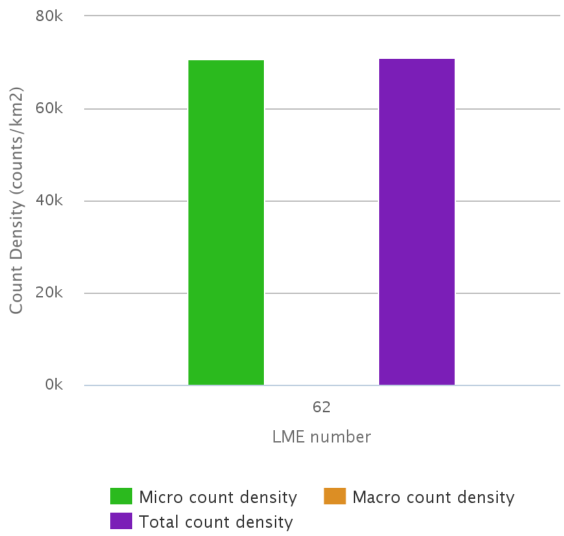
Data are available for only one sample from one location. This shows minimal concentration (ng.g [1] of pellets) of 5 for PCBs, low concentration of 15 for DDTs, and moderate concentration of 9.6 for HCHs, corresponding to categories 1,2, and 3, respectively, of the five risk categories (1 = lowest risk; 5 = highest risk). Dominance of DDT over the degradation products was observed, suggesting current inputs of DDTs. Agricultural application and/or antifouling agent may explain the DDTs, although the level was low. The sample was collected in 2009, after the onset of regulation by the Stockholm Convention. Illegal usage is suspected. Extensive monitoring is necessary in this LME.

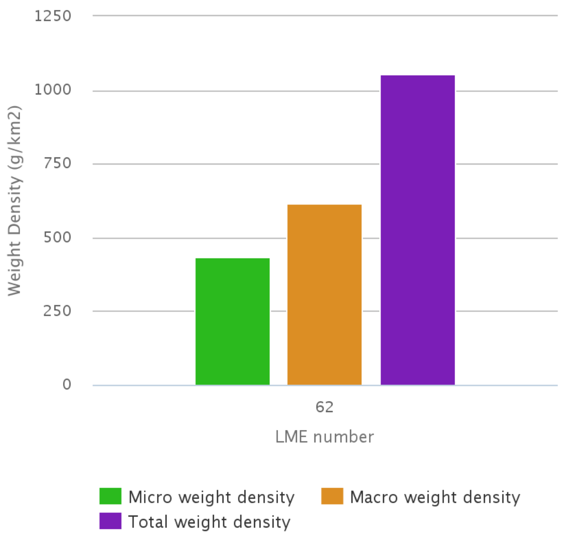
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
1	5	**1**	15	**2**	9.6	**3**

Legend: Very low, Low, Medium, High, Very high

Plastic debris

Modelled estimates of floating plastic abundance (items km ^{2}), for both micro plastic (<4.75 mm) and macro plastic (>4.75 mm), indicate that this LME is in the group with the highest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run off. The high values are due to relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 400 times higher that those LMEs with lowest values. There is moderate evidence from sea based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

Not applicable.

Reefs at risk

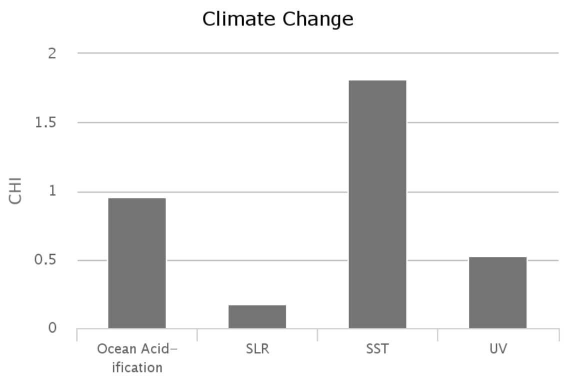
Not applicable.

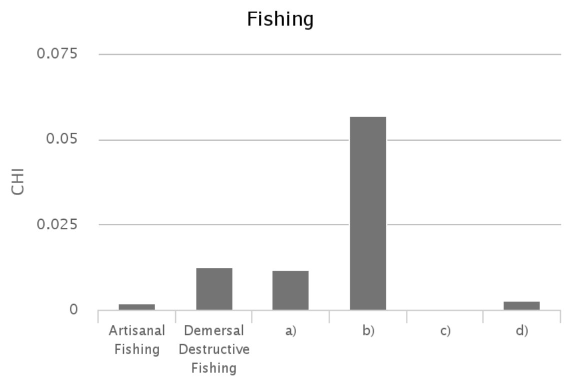
Marine Protected Area change

The Black Sea LME experienced an increase in MPA coverage from 1,905 km^2 prior to 1983 to 4,750 km^2 by 2014. This represents an increase of 149%, within the low category of MPA change.

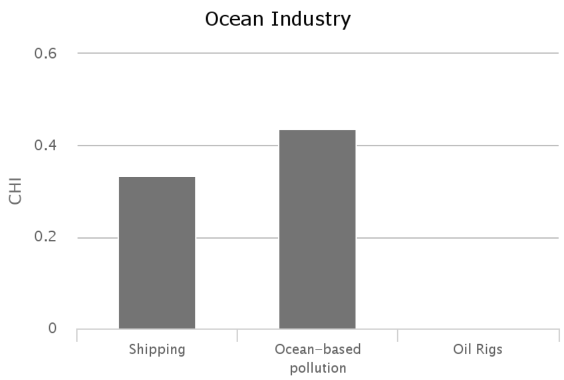
Cumulative Human Impact

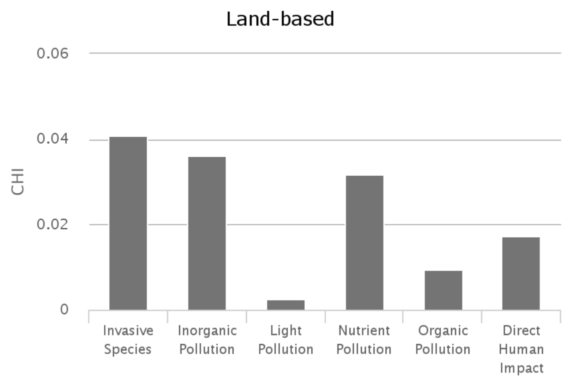
The Black Sea LME experiences well above average overall cumulative human impact (score 4.48; maximum LME score 5.22). It falls in risk category 5 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.96; maximum in other LMEs was 1.20), UV radiation (0.53; maximum in other LMEs was 0.76), and sea surface temperature (1.82; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, sea level rise, ocean based pollution, invasive species, and demersal non destructive low bycatch commercial fishing.

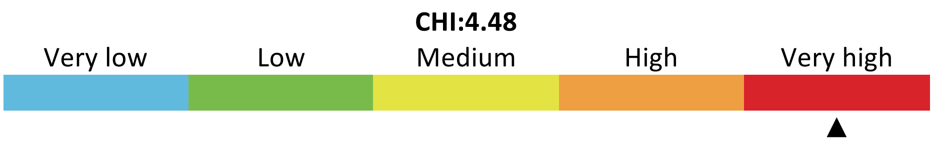




a) Demersal Non destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

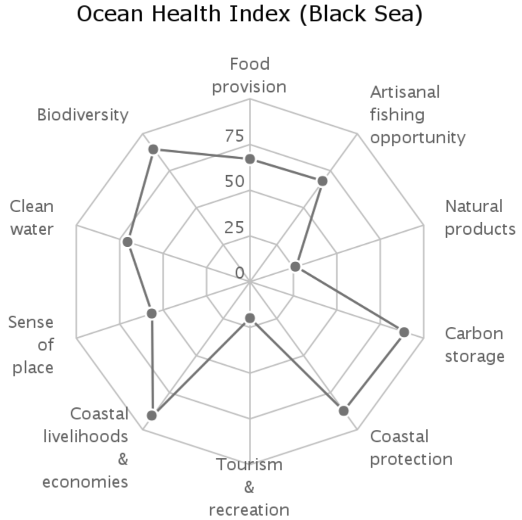






Ocean Health Index

The Black Sea LME scores below average on the Ocean Health Index compared to other LMEs (score 70 out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is well below its optimal level of ocean health, although [there are some aspects that are doing well. Its score in 2013 decreased 2 points compared to the previous year, due in large part to changes in the scores for natural products and clean waters. This LME scores lowest on mariculture, natural products, tourism & recreation and iconic species goals and highest on artisanal fishing opportunities, coastal economies, and habitat biodiversity goals. It falls in risk category 3 of the five risk categories, which is an average level f isk 1   west isk;   ighest isk).



OHI: 63.39

Socio economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 385 846 km^2. A current population of 29 487 thousand in 2010 is projected to decrease to 18 123 thousand in 2100, with a density of 76 persons per km^2 in 2010 decreasing to 47 per km^2 by 2100. About 43% of coastal population lives in rural areas, and is projected to decrease in share to 40% in 2100.

Total population		**Rural population**	
2010	**2100**	**2010**	**2100**
29,486,553	18,123,039	12,588,784	7,314,617

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 10% of the LME's coastal dwellers. This LME places in the very low risk category based on percentage and in the medium risk category using absolute number of coastal poor (present day estimate).

Coastal poor
3,062,470

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the medium revenue category in fishing revenues based on yearly average total ex vessel price of US 2013 $601 million for the period 2001 2010. Fish protein accounts for 9% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004 2013 of US 2013 $43 086 million places it in the high revenue category. On average, LME based tourism income contributes 11% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with medium risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
600,629,668	8.9	43,085,614,652	10.8	0.7929

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present day LME HDI belongs to the high HDI and low risk category. Based on an HDI of 0.760, this LME has an HDI Gap of 0.240, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent f he arshness f nd xposure o pecific xternal hocks.
HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a very high risk category (very low HDI) because of reduced income levels and population values from those in a sustainable development pathway..

	HDI 2100	
HDI	SSP1	SSP3
0.7605	0.8912	0.5700

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate Related Threat Indices utilize the HDI Gaps for present day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20 year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.
The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (*e.g.* overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).
The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway specific 2100 populations in

the 10 m × 10 km coast as exposure metrics, and development pathway specific 2100 HDI Gaps as vulnerability estimates.
Present day climate threat index of this LME is within the high risk (high threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is medium. There is no projected data for sea level rise in the Black Sea for year 2100.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.7576	0.3100	No data	No data

Legend:

Very low · Low · Medium · High · Very high

Governance

Governance architecture

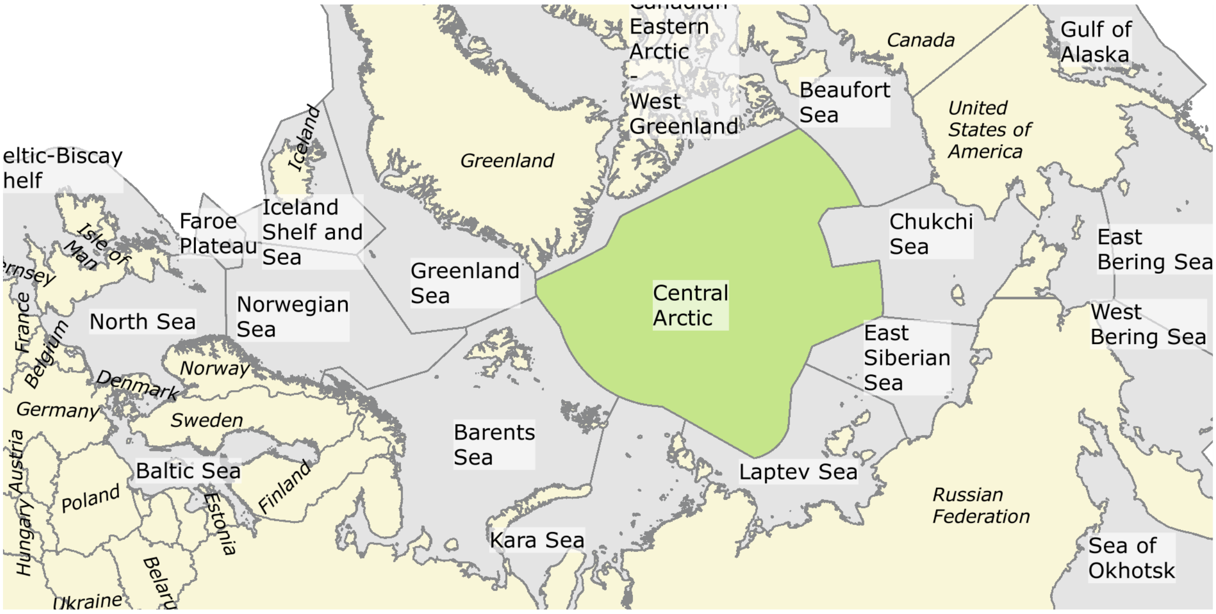
In this LME, neither of the two transboundary arrangements for fisheries (GFCM and EU CFP) nor the biodiversity arrangement for cetaceans (ACCOBAMS) appear to be linked formally. However, the two arrangements for land based and marine based pollution and biodiversity (landscape/ habitat modification) are well connected under the Bucharest Convention. No integrating mechanisms, such as an overall policy coordinating organisation for the LME, could be found. There may be interaction amongst the arrangements through participation in each other's meetings, but this appears to be informal.
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
74	**77**	**0.1**

Legend:

Very low · Low · Medium · High · Very high

LME 64 – Central Arctic



Bordering country: No country
LME Total area: 3,522,239 km^2

List of indicators

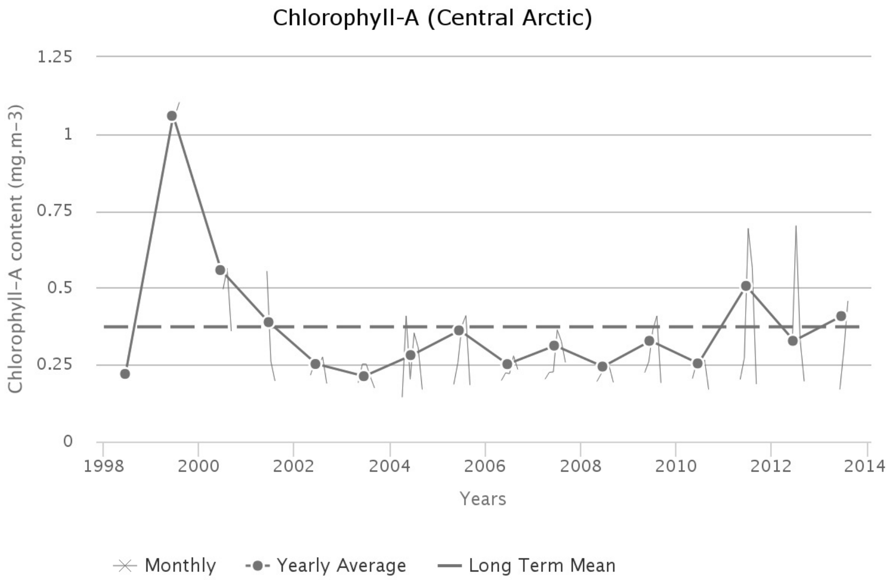
LME overall risk

This LME falls in the cluster of LMEs that exhibit high percentages of rural coastal population, high numbers of collapsed and overexploited fish stocks, as well as high proportions of catch from bottom impacting ear.
Because this LME does not have resident citizens, it has no Human Development Index and no risk score.

Productivity

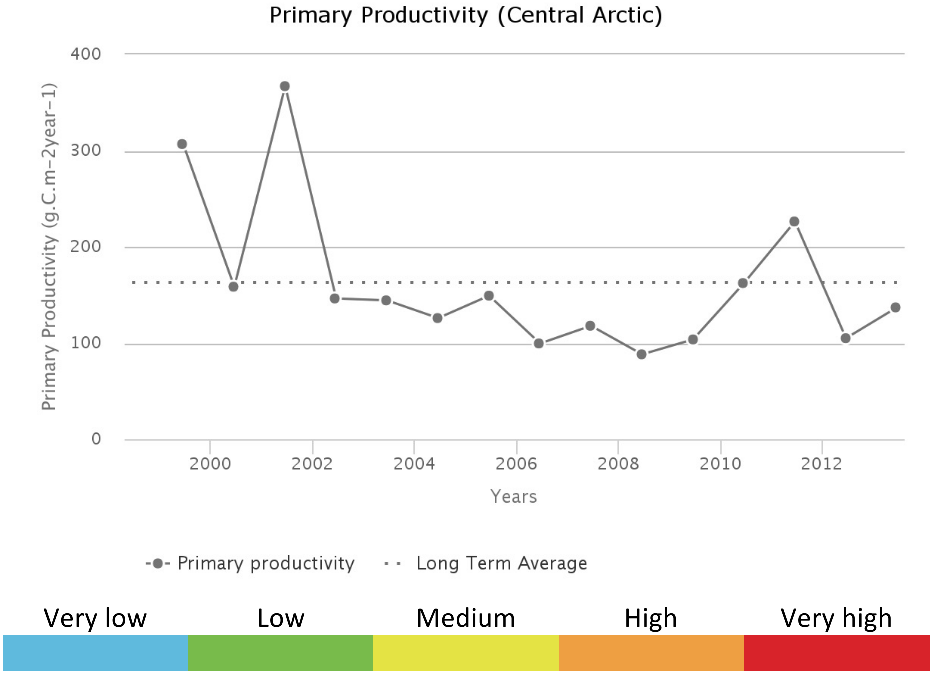
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.297 mg.m^{3}) in August and a minimum (0.169 mg.m^{3}) during April. The average CHL is 0.373 mg.m^{3}. Maximum primary productivity (367 g.C.m^{2}.y^{1}) occurred during 2001 and minimum primary productivity (88 g.C.m^{2}.y^{1}) during 2008. There is a statistically insignificant increasing trend in Chlorophyll of 139. % from 2003 through 2013. The average primary productivity is 163 g.C.m^{2}.y^{1}, which places this LME in Group 2 of 5 categories (with 1 = lowest and 5= highest).



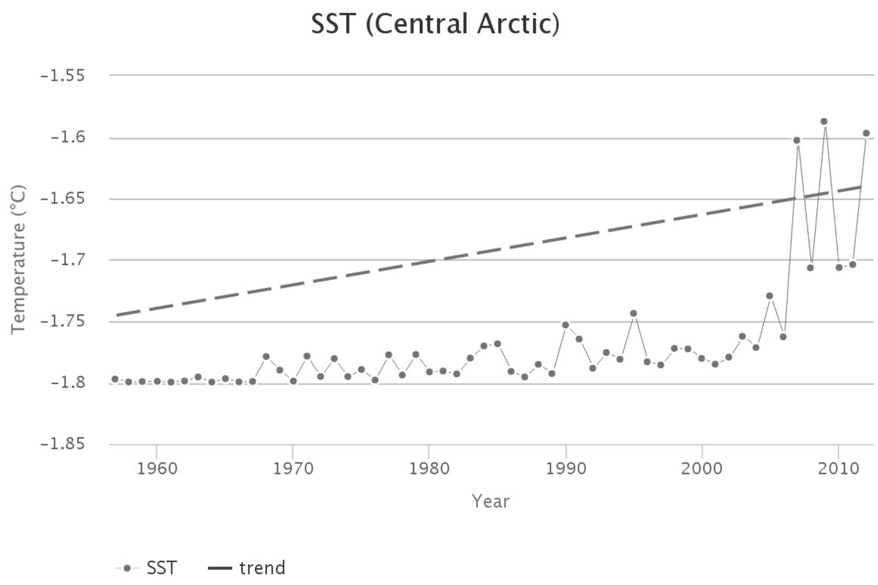
Very low | Low | Medium | High | Very high

Primary productivity



Sea Surface Temperature

From 1957 to 2012, the Central Arctic LME #64 has warmed by 0.10°C, thus belonging to Category 4 (slow warming LME). The Central Arctic is covered with ice in winter. During that time ice concentration approaches 100%. Leads between ice floes are quite rare and narrow. Wide leads or polynyas that would allow satellite measurements of SST are almost non existent. In summer the sea ice cover retreats, so that the Central Arctic become partly ice free. The annual mean SST analyzed in this report is thus based almost exclusively on summertime measurements. Because of this constraint, the thermal history of SST in this LME has not been covered in the previous analysis (Belkin, 2009). The extremely slow warming observed since 1957 through 2001 was followed by a relatively rapid warming, which was quite abrupt between 2006 2007. This abrupt shift was possibly related to the rapid shrinking of the Arctic sea ice cover observed in the 2000s. After the 2006 2007 shift, the Central Arctic SST remained stable between 2007 and 2012, notwithstanding the ongoing shrinking of the Arctic sea ice cover.

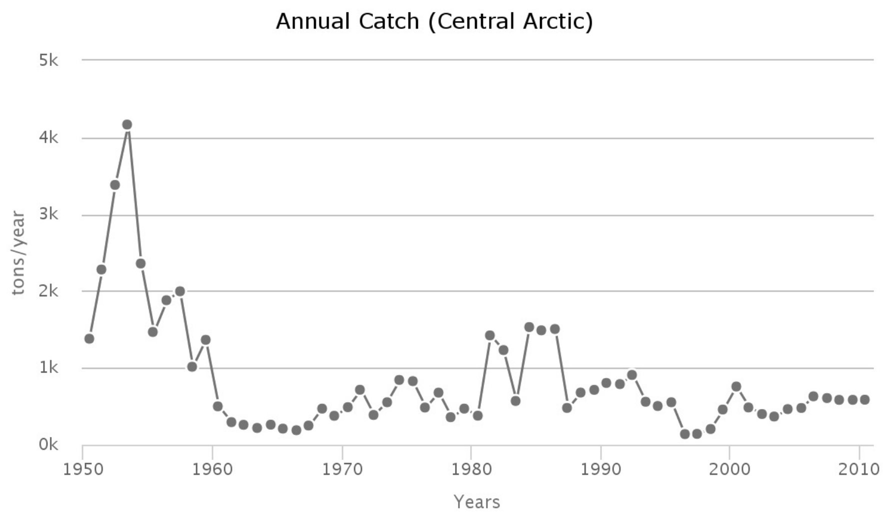


Fish and Fisheries

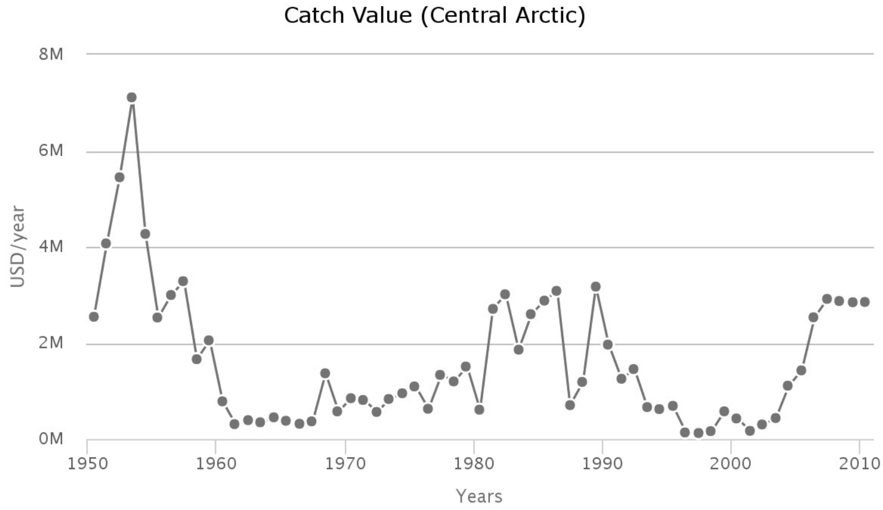
The Central Arctic LME, along with its surrounding LMEs is unique in that the melting and freezing of ice creates rich habitats close to the sunlit surface. The wide continental shelves provide large shallow areas, where freshwater from north flowing rivers creates estuarine conditions. There is a limited number of true Arctic species of commercial importance. Arctic charr (*Salvelinus alpinus*) occurs throughout the Canadian Arctic. In the summer, many stocks of Arctic char migrate to the sea, where they have a larger resource base to exploit and thus are able to grow faster. While at sea, they feed on crustaceans and small fish. Before winter, these migrants return to the rivers and lakes. Under extreme winter conditions, they hardly feed at all.

Annual Catch

Sea mammals abound and are still exploited. However, the Central Arctic LME does include waters seasonally ice free and regularly commercially fished, both in the Northwest Atlantic (around Greenland, including Davis Strait and Baffin Bay) and the Northeast Atlantic (waters north of Iceland and towards Svalbard). Thus, reported landings in this LME are dominated by catches taken in the Atlantic waters. From the 1950s to early 1970s, the catch was dominated by ocean perch and thereafter by capelin. The highest catch of about half a million t, consisting mainly of capelin, was obtained in 1996.

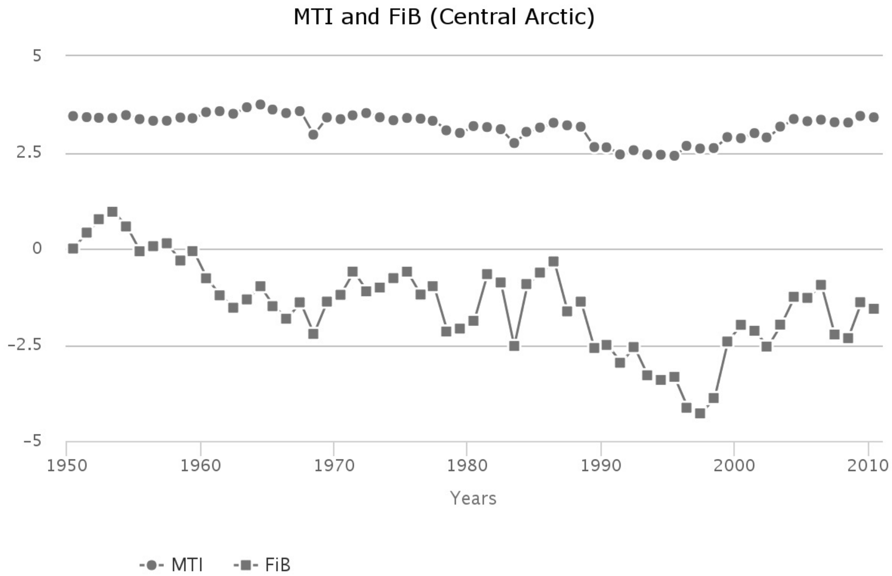


Catch value

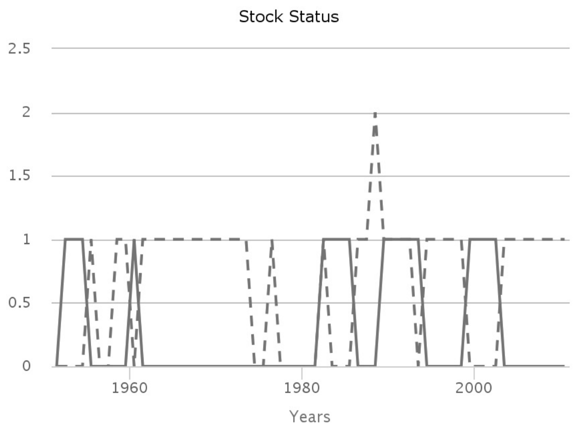


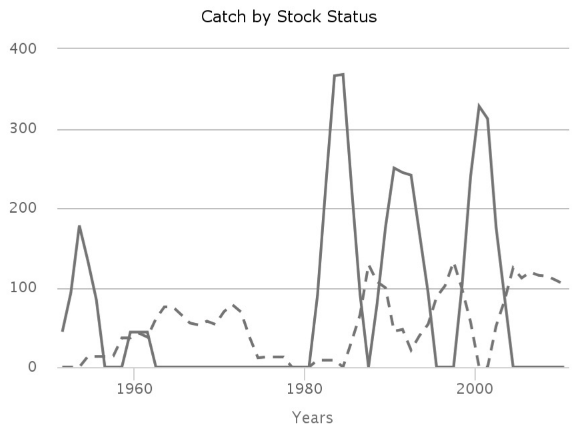
Marine Trophic Index and Fishing-in-Balance index

The catch data from this LME are too crude for ecosystem indicators such as PPR, MTI or FiB index to be computed.



Stock status

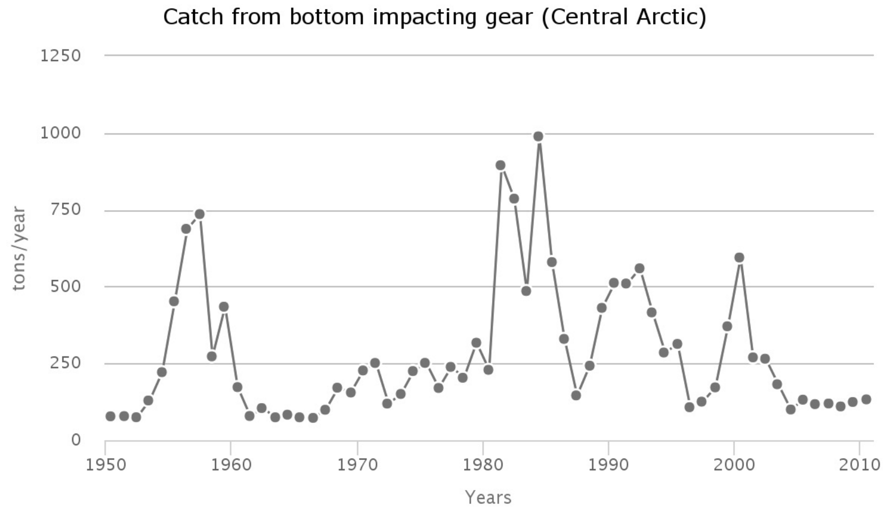




— Exploited — · Overexploited

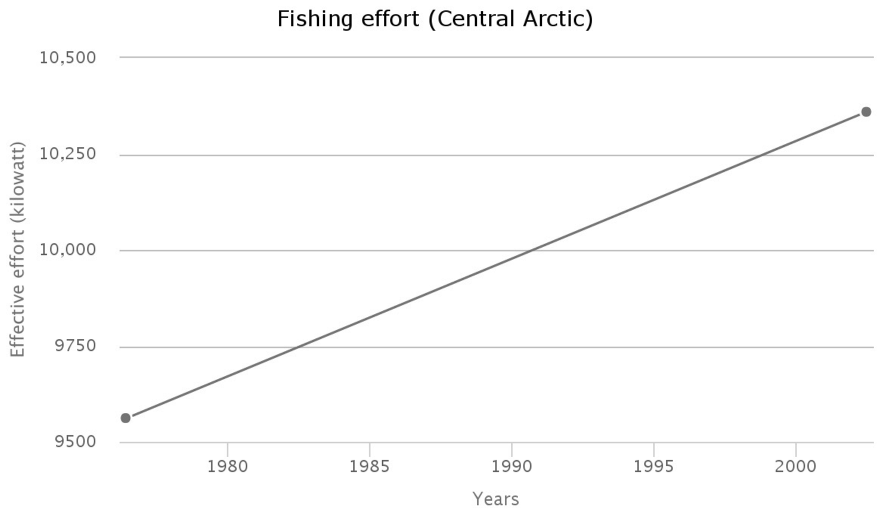
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch reached its first peak at 90% in 1996. This percentage ranged between 18 and 67% in the recent decade.

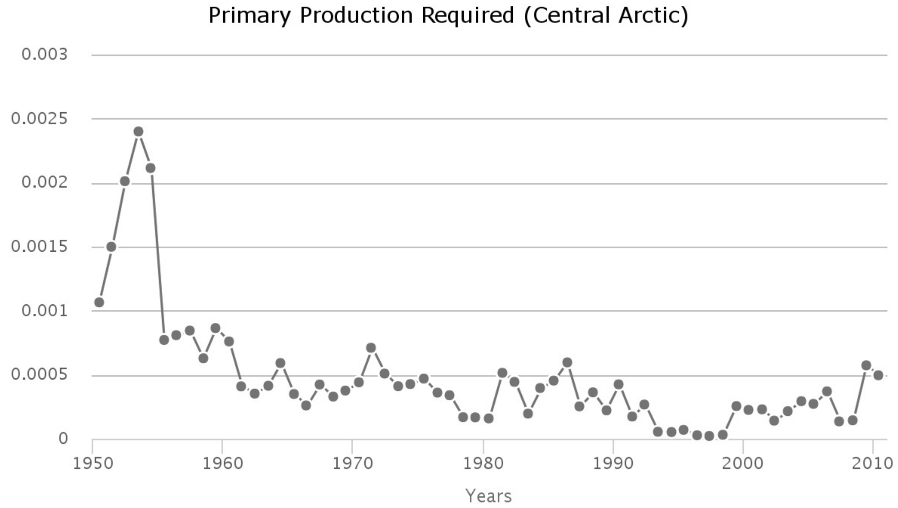


Fishing effort

The whole time series of effort data in the LME region is incomplete.



Primary Production Required



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.
An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

No data for this LME.

Nutrient ratio

No data for this LME.

Merged nutrient indicator

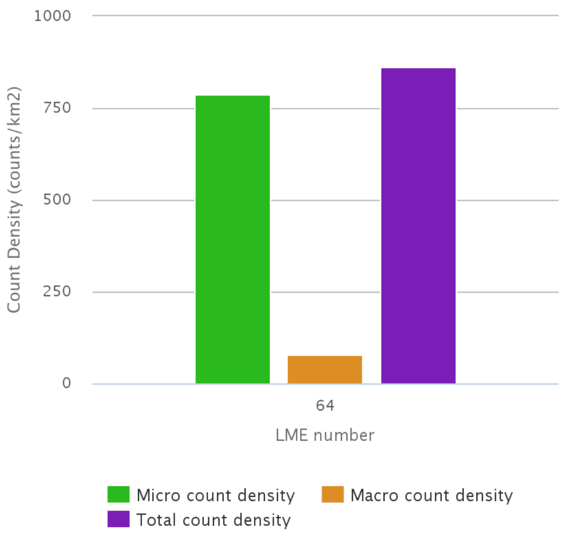
No data for this LME.

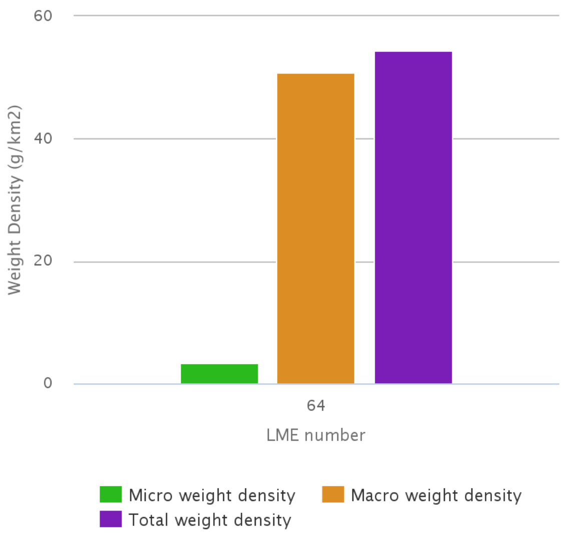
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km ^{2}), for both micro plastic (<4.75 mm) and macro plastic (>4.75 mm), indicate that this LME is in the group with relatively low levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run off. The low values are due to the relative remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be on average over 40 times lower that those LMEs with the highest values. There is limited evidence from ea based direct observations and towed nets to support this conclusion.





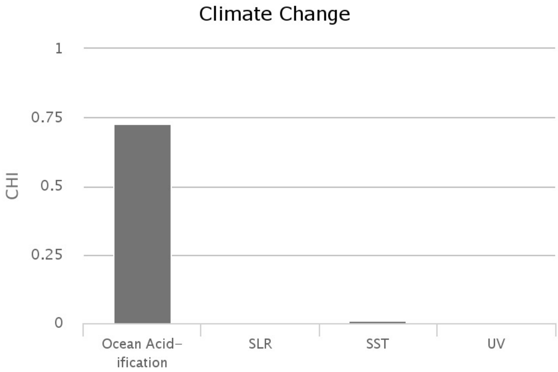
Ecosystem Health

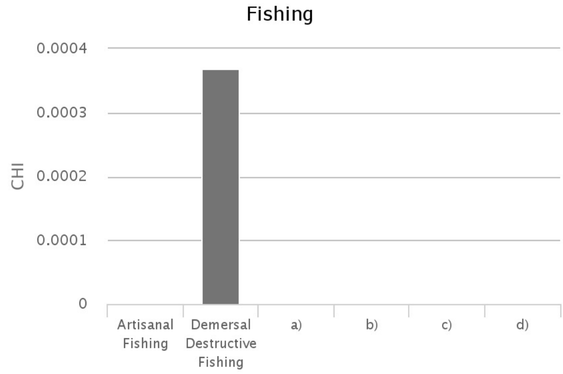
Mangrove and coral cover
Not applicable.

Reefs at risk
Not applicable.

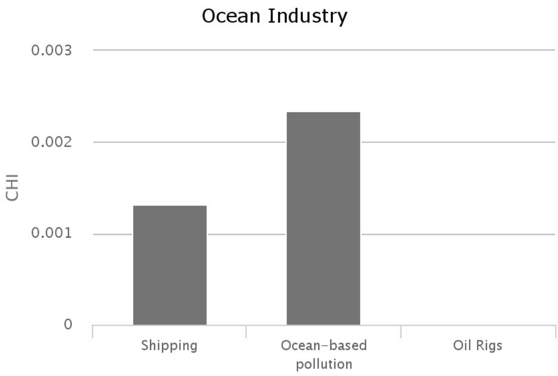
Marine Protected Area change
Not applicable.

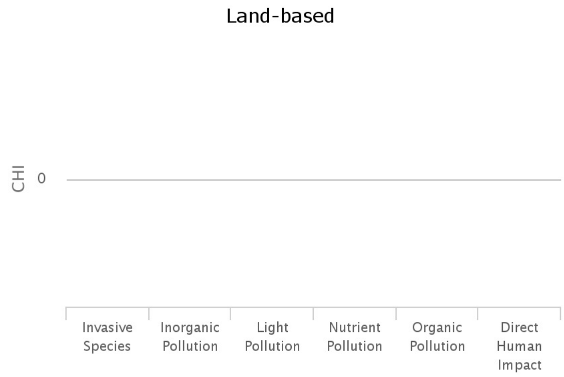
Cumulative Human Impact
The Central Arctic LME experiences one of the lowest overall cumulative human impact (score 0.74; maximum LME score 5.22). It falls in risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, the only stressor with high average impact on the LME was ocean acidification (0.73; maximum in other LMEs was 1.20), comprising 98% of the total overall impact.

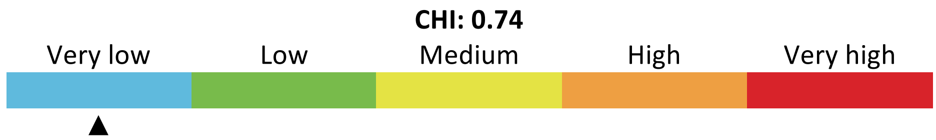




a) Demersal Non destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing



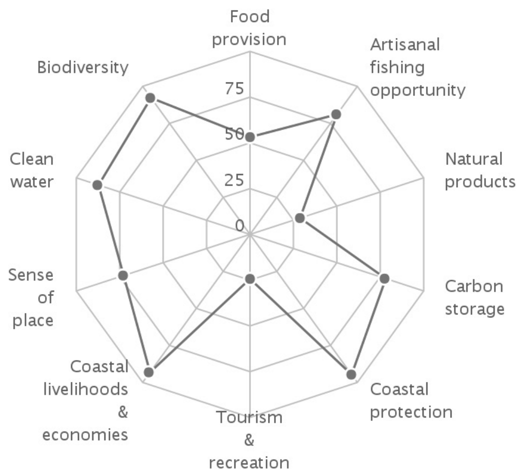




Ocean Health Index

The Central Arctic LME scores above average on the Ocean Health Index compared to other LMEs (score 74 out of 100; range for other LMEs was 57 to 82), but still relatively low. This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 1 point compared to the previous year, due in large part to changes in the score for clean waters. This LME scores lowest on food provision, natural products and tourism & recreation goals and highest on artisanal fishing opportunities, coastal protection, coastal economies, and habitat biodiversity goals. It falls in risk category 2 of the five risk categories, which is a moderate level of risk (1 = lowest risk; 5 = highest risk).

Ocean Health Index (Central Arctic)



OHI: 71.86

Very low | Low | Medium | High | Very high

Socio economics

This LME has no resident population so population related indicators are not evaluated. However, nearby countries and distant fishing nations utilize this LME for fishing and tourism, the revenues for which are reported here.

Population

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very low revenue category in fishing revenues based on yearly average total ex vessel price of US 2013 $2 million for the period 2001 2010. Its yearly average tourism revenue for 2004 2013 of US 2013 $17 277 million places it in the medium revenue category.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
No data	No data	No data	No data

Legend: Very low, Low, Medium, High, Very high

Revenues and Spatial Wealth Distribution

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
1,985,753	No data	17,277,477,680	No data	No data

Legend: Very low, Low, Medium, High, Very high

Human Development Index
(No resident population)

HDI	HDI 2100	
	SSP1	SSP3

		HDI 2100	
	HDI	SSP1	SSP3

Legend: Very low | Low | Medium | High | Very high

Climate-Related Threat Indices

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
No data	No data	No data	No data

Legend: Very low | Low | Medium | High | Very high

Governance

Governance architecture

None of the three transboundary fisheries arrangements (NEAFC, ICCAT and NASCO) appear to be integrated while the three arrangements for pollution and biodiversity (NAMMCO, ACPB and OSPAR) appear to have the Arctic Council as an integrating arrangement for one set of issues and OSPAR for a similar set of issues. However, the Arctic Council is not a binding arrangement so its implementation is voluntary and country dependent. It does appear to have the potential to develop into an informal overall policy coordinating organization, although as mentioned, its policy coordination role with respect to fisheries is weak. Consequently,, this LME has been assigned an overall integration score of 1.0 due to the presence of the Arctic Council.

The overall scores for ranking of risk were:

Engagement	Completeness	Integration
72	73	1

Legend: Very low | Low | Medium | High | Very high

UNEP-DHI PARTNERSHIP
Centre on Water and Environment

UNEP

DHI

UNESCO
United Nations
Educational, Scientific and
Cultural Organization

International
Hydrological
Programme

UNESCO
United Nations
Educational, Scientific and
Cultural Organization

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The water systems of the world – aquifers, lakes, rivers, large marine ecosystems, and open ocean- sustain the biosphere and underpin the socioeconomic wellbeing of the world's population. Many of these systems are shared by two or more nations. These transboundary waters, stretching over 71% of the planet's surface, in addition to the subsurface aquifers, comprise humanity's water heritage.

Recognizing the value of transboundary water systems and the reality that many of them continue to be degraded and managed in fragmented ways, the Global Environment Facility Transboundary Waters Assessment Programme (GEF TWAP) was developed. The Programme aims to provide a baseline assessment to identify and evaluate changes in these water systems caused by human activities and natural processes, and the consequences these may have on dependent human populations. The institutional partnerships forged in this assessment are envisioned to seed future transboundary assessments as well.

The final results of the GEF TWAP are presented in the following six volumes:
Volume 1 – ***Transboundary Aquifers and Groundwater Systems of Small Island Developing States: Status and Trends***
Volume 2 – ***Transboundary Lakes and Reservoirs: Status and Trends***
Volume 3 – ***Transboundary River Basins: Status and Trends***
Volume 4 – ***Large Marine Ecosystems: Status and Trends***
Volume 5 – ***The Open Ocean: Status and Trends***
Volume 6 – ***Transboundary Water Systems: Crosscutting Status and Trends***

A *Summary* for Policy Makers accompanies each volume. All TWAP publications are available for download at http://www.geftwap.org

This annex – Transboundary waters: A Global Compendium, Water System Information Sheets: Eastern Europe, Volume 6-Annex E -- is one of 12 annexes to the Crosscutting Analysis discussed in Volume 6. The global compendium organized into 14 TWAP regions, compiles information sheets on 765 international water systems including the baseline values of quantitative indicators that were used to establish contemporary and relative risk levels at system and regional scales. On the long term, it is envisioned that these baseline information sheets continue to be updated by future assessments at multiple spatial and temporal scales to better track the changing states of transboundary waters that are essential in sustaining human wellbeing and ecosystem health.

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