A3.34 - Fucales and other algae on Pontic sheltered upper infralittoral rock, well illuminated

Summary

The habitat is present throughout the Black Sea on areas of infralittoral rocky substrate. The depth to which *Cystoseria* spp. canopies reach is restricted by light penetration (in the past before eutrophic conditions arose, canopies reach lower depths).

Information on habitat extent is available for Romania, Bulgaria and Crimea, including historical (pre-1965) accounts of localities. Extent information is available for Turkey but only at a very coarse scale. Both quantitative and qualitative data show that the area and known occurrences of the habitat have reduced significantly in the last 50 years. Quantitative data on quality changes is available for specific sites in Bulgaria, Romania and Crimea. The general trend is for reduction in quality (biomass, species composition, morphology, etc.) within the last 50 years. Recent trends in quality and quantity (since 1990s) show evidence that the habitat is now stable. However, the area and quality of the habitat is greatly reduced from the historic (pre-1965) period.

Historically the most significant pressure has been eutrophication, causing the greatest reductions in quantity and quality. This was most acutely experienced in the north-west Black Sea where there are high riverine inputs Since the dissolution of the Soviet Union and subsequent economic collapse, industrial effluent discharge into the sea all but ceased (but could resume in future). Also, a reduction of transboundary pollution resulted from implementation of the WFD and DRPC, and extension of EU membership to Central Europe, leading to a reduction in the pressures.

Synthesis

In the EU 28 the habitat has been assessed as Endangered using Criteria C/D1. There is evidence of intermediate or moderate levels of decline affecting >80% of the habitat with substantial changes in vertical structure and the reduced cover and frequency of many characteristic species. Although there are quantitative data from sites in Romania and Bulgaria this assessment WAS mostly based on expert opinion. There is evidence of reduction at a site level and these results were extrapolated and are believed to represent the whole region.

In the EU 28+ the habitat has been assessed as Vulnerable using Criteria C/D1. There is evidence of intermediate or moderate levels of decline affecting >50% of the habitat. Intermediate or moderate decline is based on substantial changes in vertical structure and the reduced cover and frequency of many characteristic species. This is supported by quantitative data from sites in Romania, Bulgaria and Crimea. No data is available for Turkey or Georgia. Qualitative data for these countries is also lacking. The assessment has mostly been based on expert opinion.

Overall Category & Criteria			
EU 28		EU 28+	
Red List Category	Red List Criteria	Red List Category	Red List Criteria
Endangered	C/D1	Vulnerable	C/D1

Sub-habitat types that may require further examination

None

Habitat Type

Code and name

A3.34 - Fucales and other algae on Pontic sheltered upper infralittoral rock, well illuminated

Cystoseira barbata canopy visible from the surface on Varvara shallow reefs, Strandja coast, Bulgaria. (© D. Micu).

Cystoseira barbata canopy visible from the surface, Uret rocky spit, Tarhankut peninsula, Russia (© D.Micu).

Habitat description

This habitat is present in shallow sheltered waters, such as semi-enclosed bays on rocky substrates. Reported at depths of 1-14 m although also known to occur in deeper waters in the pre-eutrophication period in the early 1980s. *Cystoseira* belt, in this habitat is dominated by *C. barbata*, provides an ideal substrate and habitat for numerous photophilic and sciaphilic algal species, especially Rhodophyta.

C. barbata is typically the dominant canopy-forming species in this sheltered environment, with *C. crinita* and *C. bosphorica* being more common in exposed situations. Other species present include the algae *Ulva rigida, Polysiphonia subulifera, Cladophora* spp*., Gelidium spinosum* and occasionally present *C. crinita* and *Ceramium virgatum*. The bivalves *Mytilus galloprovincialis* and *Mytilaster lineatus* are also very abundant in this habitat and often colonise all the substrate available between the *C. barbata* plants, or attach to the main axis of the plants. An understory of *Dilophus fasciola* and *Cladostephus spongiosus* is typical of oligotrophic waters (*Cystoseiretum dilophoso-cladostephosum*). A third layer is formed by *Padina pavonia* and *Corallina elongata*. *Gelidium latifolium* with *G. spinosum* (= *G. crinale*) also present. A fourth layer of crust-forming *Hildenbrandia rubra* is also typical. Epiphytic algae include *Laurencia coronopus*, *Polysiphonia subulifera*, *Ceramium rubrum, Corynophlaea umbellata, Stilophora rhizodes,* and *Jania rubens.*

Suitable indicators of quality include: community and population structure, diversity, biomass and abundance, epiphytic species richness, water quality and substrate. Appropriate thresholds include:

1. Cystoseira spp. canopies occur in all areas with suitable habitat. Habitat fragmentation is reduced.
2. Cystoseira spp. cover inside the canopy is ≥50%
3. Height of Cystoseira spp. thalli during the cold season is ≥100 cm for at least 50% of the population
4. Epiphyte-free wet biomass of Cystoseira spp. is ≥3,000 g/m2

Classification

This habitat may be equivalent to, or broader than, or narrower than the habitats or ecosystems in the following typologies.

EUNIS (2004):

Level 4. A sub-habitat of ‘Infralittoral rock’ (A3).

Annex 1:

1160 Large shallow inlets and bays

1170 Reefs

MAES:

Marine - Marine inlets and transitional waters

Marine - Coastal

MSFD:

Shallow sublittoral rock and biogenic reef

EUSeaMap:

Shallow photic rock or biogenic reef

IUCN:

9.2 Subtidal rock and rocky reefs

Does the habitat type present an outstanding example of typical characteristics of one or more biogeographic regions?
Yes

Regions
Black

Justification
The species composition is unique to the Black Sea. In the Black Sea *Cystoseria barbata* is the canopy-forming species in sheltered situations. *Cystoseria crinita* and *C. bosphorica* dominate in more exposed areas. Associations are limited to *Ulva rigida, Polysiphonia subulifera, Cladophora* spp*., Gelidium spinosum* and occasionally present *C. crinita* and *Ceramium virgatum*. Typically the habitat consists of fewer algal species than comparable habitats in the Mediterranean Sea.

A key feature of this habitat in the Black Sea is its biomass. The productivity is very high and is considerably greater than examples found in the Mediterranean. Literature reports that.

This habitat is one of the most diverse and ecologically important habitats in the Black Sea: between 140-170 species of zoobenthos and approximately 110 macro algae species occur in it.

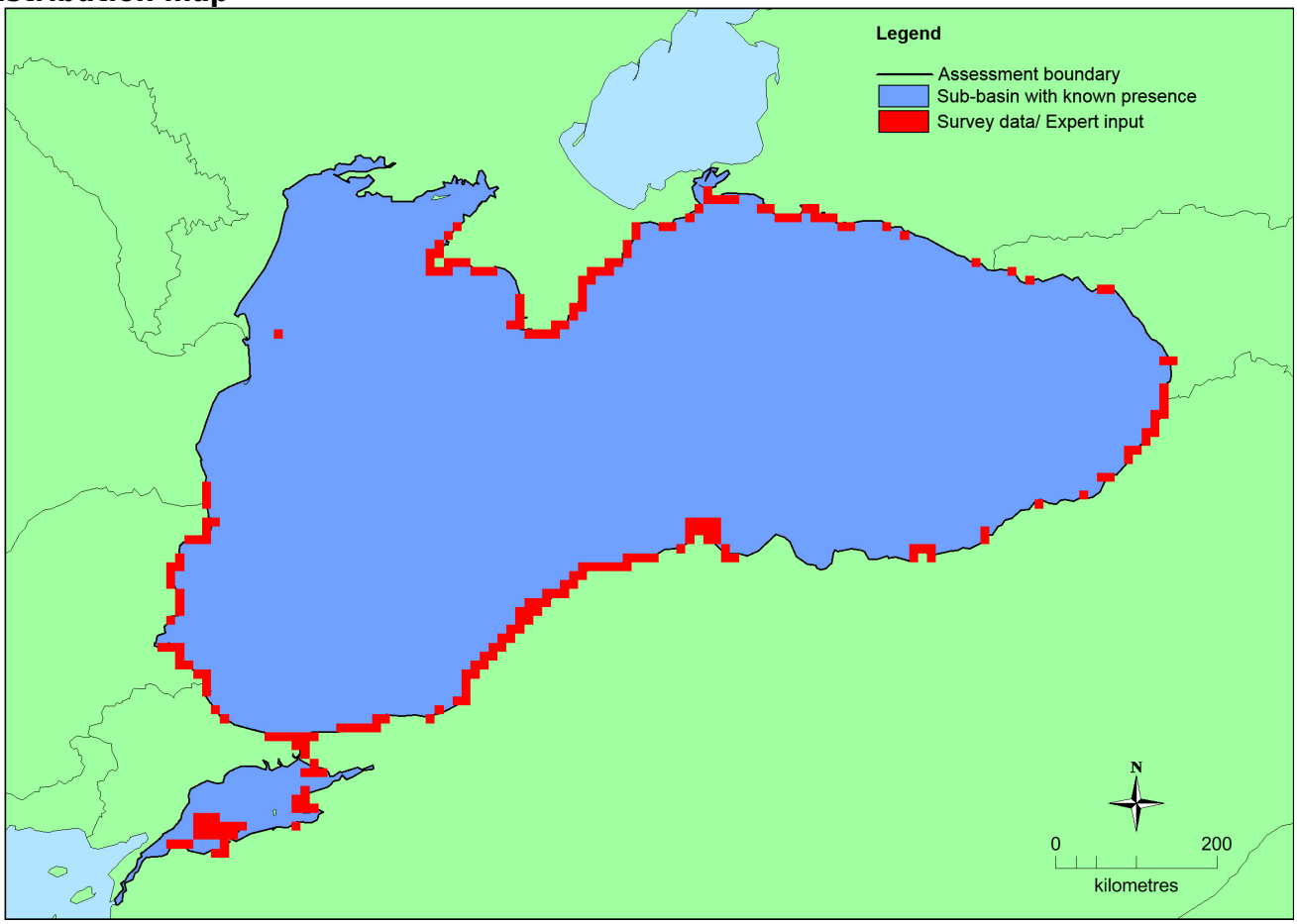
Geographic occurrence and trends

Region	Present or Presence Uncertain	Current area of habitat	Recent trend in quantity (last 50 yrs)	Recent trend in quality (last 50 yrs)
Black Sea	Black Sea: Present Sea of Marmara: Present	Unknown Km^2	Decreasing	Decreasing

Extent of Occurrence, Area of Occupancy and habitat area

	Extent of Occurrence (EOO)	Area of Occupancy (AOO)	Current estimated Total Area	Comment
EU 28	9060 Km^2	17	Unknown Km^2	Area estimates are available at some locations (e.g. sites in Crimean and Romania) However, these are only a small proportion of the total area and cannot be used as an estimate.
EU 28+	395700 Km^2	233	Unknown Km^2	Area estimates are available at some locations (e.g. sites in Crimean and Romania) However, these are only a small proportion of the total area and cannot be used as an estimate.

Distribution map



This map has been generated based on expert opinion. The map has been used to calculate AOO and EOO. The map should be treated with caution as it does not necessarily reflect the full distribution of the habitat.

How much of the current distribution of the habitat type lies within the EU 28?

Around 12% of this habitat is estimated to be hosted by the EU 28 in the Black Sea.

Trends in quantity

The historic (pre-1965) trend of the habitat is unknown: some extent data are such as the presence of *Cystoseria* spp. and general ecological details (depth of occurrence was recorded in Romania in 1926 and 1930s). The trend in habitat quality is believed to have been stable during the historic period based on knowledge of pressures and historic environmental conditions.

In the recent past (1965 to the present day) there has been a severe decline in quantity in Romania, Bulgaria, Crimea and the Caucasus. During the period up to the mid 1990s widespread and severe eutrophication occurred in the Black Sea. This was most notable in the western part, which caused a significant reduction in extent. In Romania up to 90% of extent reduction has occurred since 1971 (previously it was found on all rocky coasts, now it is greatly reduced. It should be noted that much of the extent loss has occurred at lower depths due to reduced light penetration (caused by eutrophication). In Romania the lowest recorded depth has shifted from 7 m (in the 1930s) to 3 m (2000s) and at present is improving (5 m). In Crimea a more dramatic shift has occurred: previously the habitat was recorded at depths of 97 m (1960s)while the current lowest recorded depth is 14 m (southern Bulgaria).

Data for trends in Georgia and Turkey are unavailable. However, these areas were less affected by the eutrophication period and are therefore assumed to be more stable.

Further reductions in extent in the last 50 years have been caused by coastal development in Romania, Bulgaria and Turkey. In some regions (e.g. Turkey) the habitat has colonised artificial substrates.

Since the late 1990s/2000 signs of recovery have been observed in many locations in Romania, Crimea, Turkey where the extent is reported as stable or increasing. Nevertheless extent is still considerably reduced from the pre-eutrophication period.

In the future period (next 50 years) the extent is expected to remain stable and/or show signs of slow recovery, provided that present abiotic conditions remain stable and other pressures (coastal development) do not increase.

- Average current trend in quantity (extent)
  EU 28: Stable
  EU 28+: Stable
- Does the habitat type have a small natural range following regression?
  -
  Justification
  The habitat has a small range following regression in the EU countries only. In the EU 28+ the EOO exceeds 50,000 km². The habitat has undergone an important decline in the last 50 years. This is especially true to the western Black Sea (see Trends in Quantity). However, this decline has now halted and the extent of the habitat is now stable.
- Does the habitat have a small natural range by reason of its intrinsically restricted area?
  Yes
  Justification
  The habitat can only occur on infralittoral rocky substrates. The range of this substrate occurs across the Black Sea but it is limited in terms of its area coverage.

Trends in quality

Trends in habitat quality from the historic period (pre-1965) are unknown. Based on knowledge of the habitat, its pressures and the historic envrionmental conditions the quality is believed to have been high and stable.

In the last 50 years the quality has decreased. This has been noted in response to two discrete pressures: eutrophication and coastal development.

Eutrophication caused quality declines between the 1970s and early 2000s. Decreases in biomass have been observed in Varna Bay, Bulgaria, where a reduction of 85% was recorded between 1968 and 2001. In Romania an estimated 90% of the habitat has been degraded as a result of eutrophication. This has resulted in fragmentation, reduced depth, reduced cover, reduced thallus length and reduced diversity in associated communities. In Crimea some sites have seen biomass increase within the last 50 years (e.g.

coast near Sevastopol between the Cape Fiolent and Streletskaya Bay). However, this trend is rare and most sites suffered reductions of biomass of 60-80%.

Eutrophication is also believed to have caused a change in morphology and age structure of *Cystoseria* spp. Fewer plants now reach sexual maturity meaning most new growth is restricted to vegetative forms.

Coastal development has also caused a reduction in habitat quality. In Turkey where the natural rocky substrate has been replaced by artificial hard substrate the habitat has often colonised. However, the new formation displays lower species diversity andabundance, resulting in a decreased quality.

In a shorter time scale (since late 1990s/early 2000s) there has been evidence of habitat quality becoming stable in terms of biomass and age structure. This has been observed in Romania, Bulgaria and Crimea. Providing the current abiotic conditions are maintained the habitat quality is expected to remain stable. However, future pressures due to coastal development may lead to loss of substrate.

- Average current trend in quality
  EU 28: Stable
  EU 28+: Stable

Pressures and threats

Eutrophication as a result of nutrient enrichment (N, P and organic matter) was the most significant historic pressure on the habitat. Reduced light penetration due to eutrophication caused declines in extent and quality of the habitat. Since the dissolution of the Soviet Union and subsequent economic collapse, industrial effluent discharge into the sea all but ceased (but could resume in future). Also, a reduction of transboundary pollution resulted from implementation of the WFD and DRPC, and extension of EU membership to Central Europe, leading to a reduction in the pressures.

Coastal development is a threat of current and future importance which can lead to habitat destruction and siltation in all parts of the Black Sea. In Romania, Bulgaria, Crimea and the Caucasus intensive hotel development and the creation of artificial beaches are a threat to the underlying substrate. In Turkey proposed road developments also threaten the substrate.

Changes in temperature are a threat to the habitat of current and future important. Extreme temperatures in both summer and winter can cause die offs of *Cystoseira* spp. canopies . Due to the slow growth rate and colonisation of the key species this can result in long term declines.

Severe storm events are a current and future threat to the habitat. High energy conditions can damage *Cystoseria* spp. canopies resulting in habitat fragmentation and loss. Due to the slow growth rate and colonisation rate of the key species this can result in long term declines. This threat may increase in the future if storm events become more frequent due to climate change.

· Temperature changes (e.g. rise of temperature and extremes) - future

· Storm, cyclone - future

· Nutrient enrichment (N, P, organic matter) – past, current, future

· Coastal development – current, future

List of pressures and threats

Urbanisation, residential and commercial development

Other urbanisation, industrial and similar activities

Pollution

Nutrient enrichment (N, P, organic matter)

Natural System modifications

Siltation rate changes, dumping, depositing of dredged deposits

Geological events, natural catastrophes

Storm, cyclone

Climate change

Temperature changes (e.g. rise of temperature & extremes)

Conservation and management

Current approaches to protect this habitat include designating protected areas, reduction of nutrient inputs, the protection of species.

This habitat exists within protected areas in Romania, Russia and Bulgaria. In Romania and Bulgaria it is listed as a national sub-type of Annex I of the Habitats Directive.

Additional actions should seek to expand all the current approaches to all states bordering the Black Sea. This should include efforts to improve marine water quality and reduce eutrophication.

List of conservation and management needs

Measures related to marine habitats

Other marine-related measures
Restoring marine habitats

Measures related to spatial planning

Establish protected areas/sites
Legal protection of habitats and species

Conservation status

Annex 1::

1160: MBLS U1, MMED XX

1170: MBLS U1, MMED XX

When severely damaged, does the habitat retain the capacity to recover its typical character and functionality?

Recent reduction in eutrophication levels in the Black Sea have shown that the habitat has the ability to stabilise. There is also evidence that the habitat can begin to recover where eutrophication levels remain low. Where artificial substrates have been installed the habitat has shown the ability to colonise these, albeit in a degraded form. The time scales taken for recovery will depend on abiotic conditions and the trend that these show.

Effort required

10 years
Naturally

Red List Assessment

Criterion A: Reduction in quantity

Criterion A	A1	A2a	A2b	A3
EU 28	unknown %	unknown %	unknown %	unknown %
EU 28+	unknown %	unknown %	unknown %	unknown %

There is insufficient data to apply Criterion A. Evidence of spatial decline exists but there is insufficient data on extents before declines began to make conclusions.

Criterion B: Restricted geographic distribution

Criterion B	B1				B2				B3
	EOO	a	b	c	AOO	a	b	c	
EU 28	10940 Km^2	No	No	No	27	No	No	No	No
EU 28+	523040 Km^2	No	No	No	231	No	No	No	No

The AOO and EOO are intrinsically small for the EU states. Declines in spatial extent, abiotic and biotic quality have halted. There are no threatening processes likely to cause declines in the next 30 years. However, there have been significant declines in the recent past which have left the habitat in a fragile state. The habitat exists at various locations, and there are no plausible human activities or stochastic events that may drive the habitat to be CR or Collapsed within a very short time period.

The threshold values for threatened categories are not met for the EU 28+ states.

Criterion C and D: Reduction in abiotic and/or biotic quality

Criteria C/D	C/D1		C/D2		C/D3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	100 %	Intemediate %	unknown %	unknown %	unknown %	unknown %
EU 28+	>50 %	Intemediate %	unknown %	unknown %	unknown %	unknown %

Criterion C	C1		C2		C3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	unknown %	unknown %	unknown %	unknown %	unknown %	unknown %
EU 28+	unknown %	unknown %	unknown %	unknown %	unknown %	unknown %

Criterion D	D1		D2		D3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	unknown %	unknown%	unknown %	unknown%	unknown %	unknown%
EU 28+	unknown %	unknown%	unknown %	unknown%	unknown %	unknown%

In the EU there has been a intermediate decline affecting 100% of the habitat. There is no quantitative data to support this. It is based on expert opinion. In the EU 28+ there has been an intermediate decline

affecting >50% of the habitat.

Criterion E: Quantitative analysis to evaluate risk of habitat collapse

Criterion E	Probability of collapse
EU 28	unknown
EU 28+	unknown

There is no quantitative analysis available to estimate the probability of collapse of this habitat type.

Overall assessment "Balance sheet" for EU 28 and EU 28+

	A1	A2a	A2b	A3	B1	B2	B3	C/D1	C/D2	C/D3	C1	C2	C3	D1	D2	D3	E
EU28	DD	DD	DD	DD	EN	VU	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD
EU28+	DD	DD	DD	DD	LC	LC	DD	DD	DD	DD	DD	DD	DD	DD	DD	-	DD

Overall Category & Criteria			
EU 28		EU 28+	
Red List Category	Red List Criteria	Red List Category	Red List Criteria
Endangered	C/D1	Vulnerable	C/D1

Confidence in the assessment
Medium (evenly split between quantitative data/literature and uncertain data sources and assured expert knowledge)

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References

Afanasiev, A.M. 2005. Macrophytobenthos of the Russian area of the Black Sea. *Ekologiya Morya* 68: 19-25.

Afanasiev D.F. and Korpakova, I.G. 2008. *Macrophytobenthos Russian Azov-Black Sea.* Rostov-on-Don: FGUP AzNIIRH.

Aysel, V., Kesercioğlu, T., Güner, H. and Akçay, H. 1990. Trabzon Deniz Algleri. *Proceedings of Xth National Biology Congress, Botanic Circular II*: 183-192.

Aysel, V., Erdugan, H., Sukatar, A., Güner, H. and Öztürk, M. 1996. Bartın Deniz Algleri. *Turkish Journal of Botany* 20: 251-258.

Aysel, V., Dural, B., Sukatar, A., Güner, H. and Erdugan, H. 1997. Zonguldak deniz algleri (Karadeniz, Türkiye). *Proceedings of XIIIth National Biology Congress, Hydrobiology section 5*: 311-321.

Aysel, V., Dural, B., Gönüz, A. and Okudan, E.Ş. 1998. Kirklareli (Karadeniz, Trakya, Türkiye) deniz florası. *Proceedings of XIVth National Biology Congress* 2: 333-342.

Aysel, V., Şenkardeşler, A. and Aysel, F. 2000. Ordu (Karadeniz, Türkiye) Deniz Florası. *Proceedings of Underwater Science and Technologies Meeting, SBT2000*: 61-69.

Aysel, V., Erdugan, H., Dural-Tarakçı, B., Okudan, E.Ş., Şenkardeşler, A. and Aysel, F. 2004. Marine Flora of Sinop (Black Sea, Turkey). *EU Journal of Fisheries & Aquatic Sciences* 21(1-2): 59-68.

Aysel, V., Dural-Tarakçı, B., Erdugan, H., Aysel F., Türker, E. and Tarakçı, Y. 2005. Marine Algae and Seagrasses of Samsun (Black Sea, Turkey). *Journal of Black Sea/Mediterranean Environment* 14: 53-67.

Aysel, V., Erdugan, H., Dural-Tarakçı, B. and Okudan, E.Ş. 2005. Marine Algae and Seagrasses of Giresun Shores (Black Sea, Turkey). *Journal of Black Sea/Mediterranean Environment* 11: 241-255.

Aysel, V., Erdugan, H. and Dural-Tarakçı, B. 2005. Marine Flora of Kastamonu (Black Sea, Turkey). *Journal of Black Sea/Mediterranean Environment* 11: 179-194.

Aysel, V., Erdugan, H., Dural, B. and Okudan, E.Ş. 2006. Marine Algae and Seagrasses of Tekirdag (Black Sea, Turkey). *Journal of Black Sea/Mediterranean Environment* 12: 251-256.

Bacescu, M.C., Muller G.I. and Gomoiu, M.-T. 1971. Cercetari de ecologie bentala in Marea Neagra (analiza cantitativa, calitativa si comparata a faunei bentice pontice). *Ecologie Marina*. Vol. IV. Editura Academiei R.S.R., Bucuresti. 357pp.

Berov, D. 2012. Structure of Cystoseira spp. macroalgal communities and the influence of anthropogenic factors on their distribution. Macroalgae as an indicator of the ecological state of coastal marine ecosystems in the Black Sea. PhD thesis. 285pp.

Berov, D., Deyanova, D., Georgieva, I. et al. 2012. Cystoseira sp. dominated macroalgal communities in the SW Black Sea (Burgas Bay, Bulgaria). Current State and possible long-term effects of Eutrophication. *Compt. rend. Acad. bulg. Sci*. 65(6): 821-830.

Cirik, Ş. and Cihangir, B. 1987. Karadeniz Inceburun (Sinop) çevresi bentik denizel bitkiler üzerine ilk notlar. *Ege Üniversitesi Su Ürünleri Yüksek Okulu, Su Ürünleri Dergisi* 4(13-16): 106-111.

Çulha, M., Bat, L., Türk Çulha, S. and Çelik, M.Y. 2010. Benthic mollusk composition of some facies in the upper-infralittoral zone of the southern Black Sea, Turkey. *Turkish Journal of Zoology* 34: 523-532

Dencheva, K. 1996. Macrophytes – bioindicators of the water state in Varna Bay. *Dokl. Bulg. Akad. Nauk* 49: 123-126.

Dencheva, K. 2010. State of macrophytobenthic communities and ecological status of the Varna Bay, Varna lakes and Burgas Bay. *Phytologia Balcanica* 16(1): 43-50.

Dimitrova-Konaklieva, S. 1978. Geografical analysis of marine algae of the Black Sea in Achtopol region. (In Bulgarian). *Fitologyia* 18: 22-35.

Erdugan, H., Aysel, V., Dural-Tarakçı, B., Okudan, E.Ş., and Aysel, F. 2003. Düzce, Sakarya, Kocaeli (Karadeniz, Türkiye) Deniz Algleri ve Deniz Çayırları. *Proceedings of Underwater Science and Technologies Meeting, SBT2003*: 20-29.

Erdugan, H., Aysel, V. and Güner, H. 2006. Rize-Sarp arasi deniz algleri, Karadeniz, Türkiye. *Turkish Journal of Botany* 20: 103-108.

Gönlügür Demirci, G. 2005. Sinop Yarımadasının (Orta Karadeniz) Mollusca Faunası. *Science and Engineering Journal of Fırat University* 17(3): 565-572.

Gozler, A.M., Kopuz, U. and Agirbas, E. 2010. Seasonal changes of invertebrate fauna associated with

Cystoseira barbata facies of Southeastern Black Sea coast. *African Journal of Biotechnology* 9(51): 8852-8859.

Gromov, V.V. 1979. Seasonal dynamics of macrophytobenthos Novorossiysk Bay near Cape Sherskharis. *Biologiya Morya* 51: 3-5.

Kalugina-Gutnik, A.A. 1970. *The composition and distribution of benthic vegetation in the south-eastern part of the Black Sea. Ecological and morphological studies of benthic organisms*. Kiev: Naukova Dumka. pp185-202.

Kalugina-Gutnik, A.A. 1973. Phytobenthos southern coast of Crimea and its phytogeographical composition. *Hydrobiological studies the northeastern part of the Black Sea*: 50-68.

Kalugina-Gutnik, A.A. 1974. Bottom vegetation of the Sevastopol bay. *Marine Biology. Ecology of benthic organisms* 32: 133-164.

Kalugina-Gutnik, A.A. and Kulikova, N.M. 1974. Bottom vegetation at the western coast of Crimea. *Marine Biology. Ecology of benthic organisms* 32: 111-132.

Kalugina-Gutnik, A.A. 1975. *Phytobenthos of the Black Sea*. Kyiv: Naukova Dumka. 247pp.

Kalugina-Gutnik, A.A. 1976. Bottom vegetation of the Karadag region of the Black Sea and its changes over the past 20 years. *Biologiya Morya* 36: 3-17.

Kalugina-Gutnik, A.A. 1984. Changes in bottom vegetation of the Karadag region for the period of 1970-1980. *Long-term dynamics of structure of coastal ecosystems of the Black Sea. Collective Scientific Work.* pp85-96.

Kalugina-Gutnik, A.A., Evstigneyeva, I.K. and Mironova, N.V. 1993. Changes in bottom vegetation in the open coast of the Sevastopol Bay over the period 1964-1990. *Algologia* 3(2): 42-48.

Karaçuha, A. and Gönülol, A. 2007. Sinop-Ayancık Kiyilarinin Üst-infralittoralinin Alg Florasi. *Journal of Fisheries Sciences* 1(1): 1-12.

Karaçuha, A. and Karaçuha, M.E. 2013. Changes of Macroalgae Biomass in Sinop Peninsula Coast of the Black Sea, Turkey. *Turkish Journal of Fisheries and Aquatic Sciences* 13: 725-736.

Lisovskaya, O.A. and Stepanyan, O.V. 2009. A variety of coastal macroalgae Taman Peninsula (Russia) in summer. *Algology* 19(4): 341-348.

Lisovskaya, O.A. 2011. Macrophytobenthos upper divisions of the coastal zone of the Russian Black Sea coast.

Matishov, G.G. and Stepanyan, O.V. 2014. Marine research off the coast of Abkhazia. *Nature* 11: 70-78.

Micu, D., Zaharia, T., Todorova, V. and Niţă, V. 2007. *Romanian Marine Habitats of European Interest*. Punct Ochit Publishers, Constanţa. 32pp. ISBN 978-973-88566-1-5.

Micu, D. 2008. Open Sea and Tidal Areas. *Natura 2000 Habitat Interpretation Manual for Romania*. Gafta, D. and Mountford, J.O. (Eds.). EU publication no. EuropeAid/121260/D/SV/RO. 101pp. ISBN 978-973-751-697-8.

Micu, D., Zaharia, T. and Todorova, V. 2008. Natura 2000 habitat types from the Romanian Black Sea. *The development of an indicative ecologically coherent network of marine protected areas in Romania*. Zaharia, T., Micu, D., Todorova, V., Maximov, V. and Niţă, V. (Eds.). Romart Design Publishing, Constanta. 32pp.

Milchakova, N.A. 2003. Macrophytobenthos. *The current state of biodiversity of the coastal waters of Crimea (Black Sea Sector)*. pp152-208.

Milchakova, N.A., Mironova, N.V. and Ryabogina, V.G. 2006. The current state of the resources of macrophytes in the south-western shelf of Crimea. *Ternopil National Pedag. Univ. scientific Proceedings, series Biology* 2: 87-90.

Milchakova, N.A., Bondareva, L.V., Mironova, N.V. and Ryabogina, V.G. 2011. Marine phytoresources. *The bioresources of the Black and Azov Seas.* Eremeev, V.N. et al. (Eds.). Sevastopol: Ekosi-Gidrophysika: 117-139 (in Russian).

Milchakova, N.A. 2011. *Marine plants of the Black Sea. An illustrated field guide.* Sevastopol: Digit Print. 144pp.

Mironova, N.V., Milchakova, N.A. and Aleksandrov, V.V. 2007. Long-term changes of macrophytobenthos of the certain objects of nature reserve fund of the coast of Crimea. Reserves of Crimea - 2007. *Proceedings of IV International scientific-practical Conference, dedicated to the 10th anniversary of the International Seminar 'Needs Assessment of biodiversity of the Crimea', part 1*: 115-121.

Mironova, N.V., Milchakova, N.A. and Ryabogina, V.G. 2007. Resources of macrophytes of the Gerakleysky peninsula coast and the peculiarities of their long-term dynamics (Crimea, the Black Sea). 147: 381-396.

Mironova, N.V., Milchakova, N.A. and Ryabogina, V.G. 2010. The current state of the macrophytobenthos stocks in the coastal zone of the Tarkhankut Peninsula (Black Sea). *Ternopil National Pedag. Univ. scientific Proceedings, series Biology* 3(44): 176-179.

Mironova, N.V. and Milchakova, N.A. 2012. The current state and long-term dynamics of macrophyte stocks of the Laspi Bay (Black Sea, Ukraine). *IV International. Conf*. "*Actual problems of modern algology*" *(Kyiv, 23-25 May 2012)*: 192-193.

Mironova, N.V., Milchakova, N.A. and Aleksandrov, V.V. 2015. Biomass and stocks of macrophytes as indicators of the state of macrophytobenthos (Laspi Bay, Black Sea). *Modern problems of evolution and ecology*. *Coll. Materials Intern. Conf. (Ulyanovsk, 6-8 April 2015)*: 412-419.

Mironova, N.V. (In press). Resources of macrophytes of the southeastern coast of Crimea (Black Sea). *Karadag-2014.*

Mityaseva, N.A., Maximova, O.V. and Georgiev, A.A. 2003. Macrophytes of northern part of Russian coast of the Black Sea. *Ekologiya Morya* 64: 24-29.

Moncheva, S. and Todorova, V. (Eds.). 2013. Initial assessment of the marine environment. In article 8 of msfd 2008/56/ec and noosmv (2010). 500pp.

Morozova-Vodyanitskaya, N.V. 1936. Experience quantifying bottom vegetation in the Black Sea. *Proceedings of the Sevastopol Biological Station* 5: 45-217.

Morozova-Vodyanitskaya, N.V. 1959. Vegetable Association of the Black Sea. *Proceedings of the Sevastopol Biological Station* 11: 3–28.

Öztürk, M. & Öztürk, M. 1988. Akliman ve Hamsaroz Körfezi Üst-Infralittoralinde Yer Alan Bitkisel organizmalar Üzerine Bir Araştırma. *Proceedings of TUBITAK IXth National Biology Congress* 3: 329-342.

Petrova-Karadzhova, V. 1975. Quantitative distribution and resources of the brown algae Cystoseira barbata (Good et Wood)Ag. at the Bulgarian Black Sea Coast.Izv. Inst. Ribni Resursi(Varna) (In Bulgarian). *Proceedings of the Institute of Fish Resources* 14: 100-135.

Petrova, E., Stojkov, S. and Vachkova, V. 2011. The macarozoobenthos from algal overgrowth by region of Pasha Dere south of Iape Galata (Black Sea). *Proceedings of the Union of Scientists in Varna*: 58-64.

Prodanov, K., Moncheva, S., Konsulov, A., Kamburska L., Konsulova T. and Dencheva K. 2001. Recent ecosystem trends along the Bulgarian Black Sea coast. *Proceedings of the Institute of Oceanology* 3: 110-

127.

Salomidi, M. et al. 2010. Monitoring and Evaluation of Spatially Managed Areas. Catalogue of European seabed biotopes. Deliverable 1.2. 235pp.

Teyubova, V.F. 2005. Macrophytobentos of water-line region of the Novorossisk Bay (the Black Sea) in conditions of anthropogenic affecting. *Ekologiya Morya* 69: 53-57.

Teyubova, V.F. 2005. Features interannual dynamics species composition and structure macrophytobenthos in the Bay of Novorossiysk (Black sea). *Ekologiya Morya* 69: 53–57.

Teyubova, V.F. 2012. The diversity and ecological features macrophytobenthos the Russian sector of the Black Sea. Dissertation for degree of biological sciences.

Todorova, V. and Panayotova, M. 2011. Infralittoral rocks and other hard substrates. *Red Book of Republic of Bulgaria.* Vol. III*. Natural habitats.* ISBN 978-9549746-23-5.

Vasiliu, F. 1996. Chapter 19. Marine Benthic Vegetation. Recent Changes and the Effects of Eutrophication. *Ecological Studies 123*. Schramm, W. and Nienhuis, P.H. (Eds.). Springer-Verlag.

Zaika, V.E., Boltachev, A.R., Zuev, G.V., Kovalev, A.V., Milchakova, N.A. and Sergeeva, N.G. 2004. Floristic and faunistic changes in the Crimean Black Sea shelf after 1995–1998. *Marine Ecological Journal* 3(2): 37-44.

Zinova, E.S. 1935. Algae Black Sea resort of Novorossiysk Bay and their use. *Proceedings of the Sevastopol Biological Station* 4: 5-136.