18. Turbot (*Scophthalmus maximus*)

Sensitivity Assessment

Table A11.18. Sensitivity assessment for Turbot (*Scophthalmus maximus*). Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive.

Pressures		**Associated sector(s)**	**Resistance**				**Resilience**				**Sensitivity**			
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**
Physical	Physical loss (to land or freshwater habitat)	O	L	H	H	H	M	M	M	M	M	M	M	M
	Physical change (to another seabed type)	O, F	L	H	H	H	M	M	M	M	M	M	M	M
	Physical change (to another sediment type)	O, F	L	H	H	H	M	M	M	M	M	M	M	M

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**
	Habitat structure change-removal of substratum (extraction)	O	L	H	H	H	M	M	M	M	M	M	M	M
	Abrasion/disturbance of substratum surface or seabed	O, F	M	M	M	M	H	NR	NR	NR	L	NR	NR	NR
	Penetration or disturbance of substratum subsurface	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Changes in suspended solids (water clarity)	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**
Physical	Smothering and siltation changes (light)	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Smothering and siltation changes (heavy)	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Barrier to species movement	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hydrological	Water flow changes	O	M	M	H	M	M	M	M	M	M	M	H	M

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**
Chemical	Transition elements & organo-metal contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Hydrocarbon & PAH contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Synthetic compound contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Introduction of other substances	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Deoxygenation	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**
	Removal of target species	F	L	H	H	H	M	H	H	H	M	H	H	H
	Removal of non-target species	F	L	H	H	H	M	H	H	H	M	H	H	H

References for sensitivity assessment

1. Basaran, F., & Samsun, N. (2004). Survival rates of black sea turbot (*Psetta maxima maeotica*, L. 1758) broodstock captured by gill nets from different depths and their adaptation culture conditions. *Aquaculture International*, 12, 321-331. https://doi.org/10.1023/B:AQUI.0000036183.39217.2a

2. Burel, C., Person-Le Ruyet, J., Gaumet, F., Le Roux, A., Severe, A., & Boeuf, G. (1996). Effects of temperature on growth and metabolism in juvenile turbot. *Journal of Fish Biology*, 49(4), 678-692. https://doi.org/10.1006/jfbi.1996.0196

3. Caputo, V., Candi, G., Colella, S., & Arneri, E. (2001). Reproductive biology of turbot (*Psetta maxima*) and brill (*Scophthalmus rhombus*) (Teleostei, Pleuronectiformes) in the Adriatic Sea. *Italian Journal of Zoology*, 68(2), 107-113. https://doi.org/10.1080/11250000109356393

4. Cardinale, M., Chanet, B., Martínez Portela, P., Munroe, T.A., Nimmegeers, S., Shlyakhov, V., Turan, C. & Vansteenbrugge, L. (2021). *Scophthalmus maximus*. *The IUCN Red List of Threatened Species* 2021: e.T198731A144939322. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T198731A144939322.en

5. Ellis, T., Howell, B. R., & Hayes, J. (1997). Morphological differences between wild and hatchery-reared turbot. *Journal of Fish Biology*, 50(5), 1124-1128. https://doi.org/10.1006/jfbi.1996.0364

6. Florin, A. B., & Höglund, J. (2007). Absence of population structure of turbot (*Psetta maxima*) in the Baltic Sea. *Molecular Ecology*, *16*(1), 115-126. https://doi.org/10.1111/j.1365-294X.2006.03120.x

7. Haynes, P. S., Brophy, D., McGrath, D., O'Callaghan, R., Comerford, S., & Casburn, P. (2010). Annual and spatial variation in the abundance length and condition of juvenile turbot (*Psetta maxima* L.) on nursery grounds on the west coast of Ireland: 2000–2007. *Journal of Sea Research*, 64(4), 494-504. https://doi.org/10.1016/j.seares.2010.01.009

8. Imsland, A. K., Sunde, L. M., Folkvord, A., & Stefansson, S. O. (1996). The interaction of temperature and fish size on growth of juvenile turbot. *Journal of Fish Biology*, *49*(5), 926-940. https://doi.org/10.1111/j.1095-8649.1996.tb00090.x

9. Kerambrun, E., Henry, F., Rabhi, K., & Amara, R. (2014). Effects of chemical stress and food limitation on the energy reserves and growth of turbot, *Scophthalmus*

maximus. *Environmental Science and Pollution Research*, *21*, 13488-13495. https://doi.org/10.1007/s11356-014-3281-1

10. Laikre, L., Palm, S., & Ryman, N. (2005). Genetic population structure of fishes: implications for coastal zone management. *AMBIO: A Journal of the Human Environment*, 34(2), 111-119. https://doi.org/10.1639/0044-7447(2005)034[0111:GPSOFI]2.0.CO;2

11. Lennquist, A., Hilvarsson, A., & Förlin, L. (2010). Responses in fish exposed to medetomidine, a new antifouling agent. *Marine Environmental Research*, 69, S43-S45. https://doi.org/10.1016/j.marenvres.2010.01.004

12. Maruya, K. A., Vidal-Dorsch, D. E., Bay, S. M., Kwon, J. W., Xia, K., & Armbrust, K. L. (2012). Organic contaminants of emerging concern in sediments and flatfish collected near outfalls discharging treated wastewater effluent to the Southern California Bight. *Environmental Toxicology and Chemistry*, 31(12), 2683-2688. https://doi.org/10.1002/etc.2003

13. Mhadhbi, L., Boumaiza, M., & Beiras, R. (2010). A standard ecotoxicological bioassay using early life stages of the marine fish *Psetta maxima*. Aquatic living resources, 23(2), 209-216. https://doi.org/10.1051/alr/2010014

14. Panayotova, M., Raykov, V., Maximov, V., Radu, G., & Anton, E. (2012). Distribution, abundance and population structure of Turbot (*Psetta maxima* L.) in the Bulgarian and Romanian Black Sea area in spring 2010. *Comptes rendus de l'Académie bulgare des Sciences*, 65(1*),* 63-66.

15. Person-Le Ruyet, J., Lacut, A., Le Bayon, N., Le Roux, A., Pichavant, K., & Quéméner, L. (2003). Effects of repeated hypoxic shocks on growth and metabolism of turbot juveniles. *Aquatic Living Resources*, *16*(1), 25-34. https://doi.org/10.1016/S0990-7440(02)00002-5

16. Pichavant, K., Person-Le-Ruyet, J., Bayon, N. L., Severe, A., Roux, A. L., & Boeuf, G. (2001). Comparative effects of long-term hypoxia on growth, feeding and oxygen consumption in juvenile turbot and European sea bass. *Journal of Fish Biology*, 59(4), 875-883. https://doi.org/10.1006/jfbi.2001.1702

17. Polak-Juszczak, L. (2015). Selenium and mercury molar ratios in commercial fish from the Baltic Sea: additional risk assessment criterion for mercury exposure. *Food control*, 50, 881-888.

18. https://doi.org/10.1016/j.foodcont.2014.10.046

19. Pranovi, F., Monti, M. A., Caccin, A., Brigolin, D., & Zucchetta, M. (2015). Permanent trawl fishery closures in the Mediterranean Sea: An effective management strategy?. *Marine Policy*, 60, 272-279. https://doi.org/10.1016/j.marpol.2015.07.003

20. Rijnsdorp, A. D., van Overzee, H. M., & Poos, J. J. (2012). Ecological and economic trade-offs in the management of mixed fisheries: a case study of spawning closures in flatfish fisheries. *Marine Ecology Progress Series*, 447, 179-194. https://doi.org/10.3354/meps09519

21. Sparrevohn, C. R., & Støttrup, J. G. (2008). Diet, abundance, and distribution as indices of turbot (*Psetta maxima* L.) release habitat suitability. *Reviews in Fisheries Science*, 16(1-3), 338-347. https://doi.org/10.1080/10641260701686846

22. Ustups, D., Bergström, U., Florin, A. B., Kruze, E., Zilniece, D., Elferts, D., Knospina, E., & Uzars, D. (2016). Diet overlap between juvenile flatfish and the invasive round goby in the central Baltic Sea. *Journal of Sea Research*, *107,* 121-129. https://doi.org/10.1016/j.seares.2015.06.021

23. Valente, L. M., Moutou, K. A., Conceicao, L. E., Engrola, S., Fernandes, J. M., & Johnston, I. A. (2013). What determines growth potential and juvenile quality of farmed fish species?. *Reviews in Aquaculture*, 5, S168-S193. https://doi.org/10.1111/raq.12020

24. van Bussel, C. G., Mahlmann, L., Kroeckel, S., Schroeder, J. P., & Schulz, C. (2013). The effect of high ortho-phosphate water levels on growth, feed intake, nutrient utilization and health status of juvenile turbot (*Psetta maxima*) reared in intensive recirculating aquaculture systems (RAS). *Aquacultural engineering*, 57, 63-70. https://doi.org/10.1016/j.aquaeng.2013.08.003

25. van Bussel, C. G., Schroeder, J. P., Wuertz, S., & Schulz, C. (2012). The chronic effect of nitrate on production performance and health status of juvenile turbot (Psetta maxima). *Aquaculture*, *326*, 163-167. https://doi.org/10.1016/j.aquaculture.2011.11.019

26. van der Hammen, T., Poos, J. J., van Overzee, H. M., Heessen, H. J., Magnusson, A., & Rijnsdorp, A. D. (2013). Population ecology of turbot and brill: What can we

learn from two rare flatfish species?. *Journal of Sea Research*, 84, 96-108. https://doi.org/10.1016/j.seares.2013.07.001

27. Wang, X. A., Ma, A., Huang, Z., Sun, Z., Cui, W., Qu, J., & Yu, H. (2019). Estimation of genetic parameters for upper thermal tolerances and growth-related traits in turbot *Scophthalmus maximus*. *Journal of oceanology and limnology*, 37(5), 1736-1745. https://doi.org/10.1007/s00343-019-7267-1

28. Weltzien, F. A., Planas, M., & Fyhn, H. J. (1999). Temperature dependency of early growth of turbot (*Scophthalmus maximus* L.) and its implications for developmental progress. *Journal of experimental marine biology and ecology*, 242(2), 201-210. https://doi.org/10.1016/S0022-0981(99)00099-4

Literature search

Web of Science search terms

AB=("Scophthalmus maximus" OR "S. maximus") AND AB=("angl*" OR “beam” OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR “gear” OR "gillnet*" OR "hook*" OR “injury” OR "net*" OR "otter trawl*" OR “remov*” OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR “ship*” OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR “deoxy*” OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR “exposure” OR

"heavy metals" OR "hydrocarbon" OR "hypoxia" OR “litter*” OR “non-native*” OR “ "nitrate*" OR "nitrite*" OR "noise" OR “radionuclide” OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR “regime” OR "sedimentation" OR "silt*" OR "tributyltin" OR “turbid*”)

Database

ISI Web of Science

https://www.webofscience.com/wos/woscc/summary/fa3ef578-304a-4a10-9430-eb1fea555b6e-cb38492f/relevance/1

Search date

28th February 2023 - 856 results

Search output and screening process

Abstracts screened for relevance i.e. must describe turbot and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening

As turbot is grown in aquaculture in some areas, many of the resultant papers were related to non-natural conditions. 26 papers passed the screening and formed the basis of the sensitivity assessment, supplemented with the latest IUCN Red List assessment (2021).