

NPWS

Tacumshin Lake SAC
(site code: 000709)

**Conservation objectives supporting document-
Coastal lagoons**

Version 1
May 2018

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Please note that this document should be read in conjunction with the following report: NPWS (2018) Conservation Objectives: Tacumshin Lake SAC 000709. Version 1.0. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht.

1. Introduction

1.1 Tacumshin Lake SAC

Tacumshin Lake SAC is selected for five habitats listed on Annex I of the EU Habitats Directive including coastal lagoons (EU Habitats Directive code 1150), sand dune habitats and perennial vegetation of stony banks (1220).

“Coastal lagoons” is a priority habitat in Annex I of the EU Habitats Directive. A coastal lagoon is a lake or pond that is fully or partially separated from the sea by a permeable barrier that can be entirely natural, such as shingle, or can be an artificial embankment. Salinity varies depending on factors such as freshwater inputs and barrier permeability. Lagoons support unique assemblages of flora and fauna, particularly invertebrates. In Ireland, coastal lagoons are considered to be in bad conservation status due to issues such as drainage and water pollution (NPWS, 2013).

A single lagoon, Tacumshin Lake, is listed for this SAC (Oliver, 2007). Tacumshin Lake is a shallow coastal lagoon situated on the south Co. Wexford coast, halfway between Kilmore Quay and Carnsore Point. The lagoon was formerly a shallow sea bay which over time has become separated from the sea by a gravel/sand spit. This spit has extended across the mouth of the bay from east to west due to long-shore drift.

The table below gives the conservation status assessment of Tacumshin Lake as outlined in Oliver (2007). See the map in Appendix 1 and see Appendix 2 for an account of the Tacumshin Lake site (from Oliver, 2007).

Code ¹	Name	County	Conservation Assessment
IL007	Tacumshin Lake	Wexford	Unfavourable - Bad

¹ Code is that used in Oliver (2007)

1.2 Conservation objectives

A site-specific conservation objective aims to define the favourable conservation condition of a habitat or species at site level. The maintenance of habitats and species within sites at favourable condition will contribute to the maintenance of favourable conservation status of those habitats and species at a national level.

Conservation objectives are defined using attributes and targets that are based on parameters as set out in the Habitats Directive for defining favourable status, namely area, range, and structure and functions.

Provisional reference conditions for Irish lagoons are proposed by Roden and Oliver (2013). Reference conditions aim to define ecological status prior to human impacts (i.e. “natural” conditions). The targets for the water quality attributes given below are based on reference values given by Roden and Oliver (2013).

Attributes and targets may change/become more refined as further information becomes available.

2. Area

The favourable reference area for Tacumshin Lake is 380.7ha. This area is calculated from spatial data derived from Oliver (2007).

The target for habitat area is: stable or increasing, subject to natural processes.

3. Range

The mapped distribution of the lagoon habitat (i.e. Tacumshin Lake) in Tacumshin Lake SAC is shown in Appendix 1.

The target for the habitat distribution attribute is: no decline, subject to natural processes.

4. Structure and functions

Structure and functions relates to the physical components of a habitat (“structure”) and the ecological processes that drive it (“functions”). For lagoons, these include attributes such as salinity, hydrology and various water quality attributes.

4.1 Salinity regime

Lagoons can vary considerably in salinity both within and between sites depending on the volume and timing of inflowing and outflowing freshwater and seawater. Salinity is probably the most important variable in the classification of lagoon types (Roden and Oliver, 2013). Freshwater enters Tacumshin Lake by several small streams and leaves through the barrier through the outlet pipes and by seaward percolation. Washover occurs in the south-western area of the lake. Salinities range from 3psu to 19psu (practical salinity units). Using information from Oliver (2007), the salinity class of this lake is oligohaline. See Roden and Oliver (2013) for further information on salinity classes and Appendix 2 for the site report.

The target for the salinity regime attribute is: median annual salinity and temporal variation within natural range.

4.2 Hydrological regime

Fluctuations in water depth are a natural feature of lagoon hydrology. However, if water levels fluctuate beyond their natural values due to issues such as drainage, the condition of the habitat can deteriorate. Tacumshin Lake can be classified as shallow (less than 2m), thus, even small changes in water depth can cause significant losses in habitat area. Further information is required to investigate historic fluctuations to enable more specific targets to be set. See Appendix 2 for the site report.

The target for hydrological regime is: annual water level fluctuations and minima within natural ranges.

4.3 Barrier: connectivity between lagoon and sea

The morphology of the barrier between a lagoon and the sea determines how it functions ecologically. Changes to the barrier can be due to natural processes such as storms, but they can also be modified through human intervention. Active management is sometimes necessary, particularly if the lagoon is artificial.

Tacumshin Lake is described as a large natural sedimentary lagoon with a sand/shingle barrier through which there is a permanent outlet (Oliver, 2007). See Appendix 2 for the site report.

The target for the attribute barriers: connectivity between lagoon and sea is: appropriate hydrological connections between lagoons and sea, including where necessary, appropriate management.

4.4 Water quality - Chlorophyll *a*

This attribute indicates the level of phytoplankton in the water column. Roden and Oliver (2013) make the assumption that, for shallow lagoons in “natural” condition, primary productivity is dominated by the benthos rather than the plankton. Phytoplankton tends to increase in density in response to increasing nutrient levels. Excessive shading from phytoplankton can reduce submergent macrophyte colonisation of the littoral zone of lagoons.

The target for the attribute water quality - Chlorophyll *a* is: annual median chlorophyll *a* within natural ranges and less than 5µg/L. The target is based on Roden and Oliver (2013).

4.5 Water quality - Molybdate reactive phosphorus (MRP)

The target for the attribute water quality - Molybdate Reactive Phosphorus (MRP) is: annual median MRP within natural ranges and less than 0.1mg/L. The target is based on Roden and Oliver (2013).

This limit is required to ensure that excessive shading from phytoplankton does not reduce submergent colonisation of the littoral zone.

4.6 Water quality - Dissolved inorganic nitrogen (DIN)

The target for the attribute water quality - Dissolved Inorganic Nitrogen (DIN) is: annual median DIN within natural ranges and less than 0.15mg/L. The target is based on Roden and Oliver (2013).

As for phosphorus, the limit set for nitrogen is to ensure that excessive shading from phytoplankton does not reduce submergent colonisation.

4.7 Depth of macrophyte colonisation

Tacumshin Lake has been identified as shallow (less than 2m), thus, it is expected that macrophytes should extend down to its full depth.

The target for the attribute depth of macrophyte colonisation is: macrophyte colonisation to maximum depth of the lagoon.

4.8 Typical plant species

As lagoonal specialist species do not easily recolonise, their presence is one of the indicators of long-term continuity of quality. The plant species recorded in Tacumshin Lake are summarised in Oliver (2007). Species considered to be lagoonal specialists include *Chara canescens*, *Ruppia* cf. *maritima*, *Zannichellia palustris* and *Ranunculus baudotii*. Tacumshin Lake is one of only six sites in Ireland where the rare charophyte *C. canescens* has been recorded. This species is in decline in Europe and therefore this is a very important site in European terms. See Appendix 2 for the site report.

The target for the attribute typical plant species is: maintain number and extent of listed lagoonal specialists, subject to natural variation.

4.9 Typical animal species

Some invertebrate species are regarded as lagoonal specialists and their presence can indicate long-term quality. As species found within each lagoon can vary considerably, depending on other attributes such as salinity, the target is based on site-specific species lists. A total of eight lagoonal specialists were recorded from Tacumshin Lake. These include the isopod *Lekanesphaera hookeri*, the decapod crustacean *Palaemonetes varians*, the Hemipteran insects *Notonecta viridis*, *Plea leachi* and *Sigara stagnalis*, the water-beetle *Enochrus halophilus* and the molluscs *Hydrobia ventrosa* and *Cerastoderma glaucum*. The species recorded at the site are summarised in Oliver (2007). See Appendix 2 for the site report.

The target for the attribute typical animal species is: maintain listed lagoon specialists, subject to natural variation.

4.10 Negative indicator species

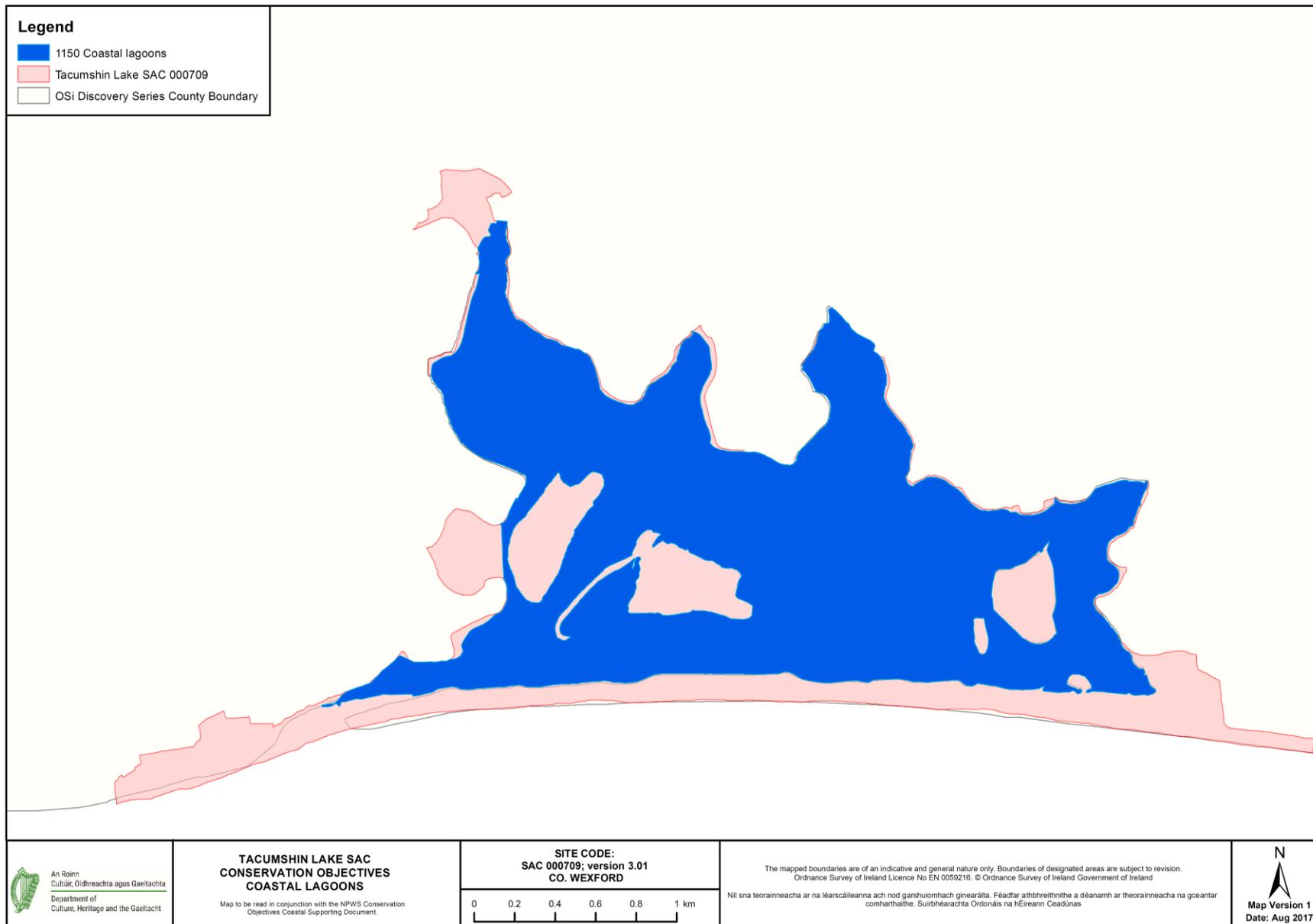
Negative indicator species include non-native alien species as well as those that are not typical of the habitat. For example, accelerated encroachment by reedbeds can be caused by low salinity, shallow water and elevated nutrient levels.

The target for the attribute negative indicator species is: negative indicator species absent or under control.

5. References

- NPWS (2013) The status of EU protected habitats and species in Ireland. Unpublished report, National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin.
- Oliver, G. (2007) Inventory of Irish coastal lagoons (version 2). Unpublished report to the National Parks and Wildlife Service.
- Roden, C.M. and Oliver, G. (2013) Monitoring and assessment of Irish lagoons for the purpose of the EU Water Framework Directive. Unpublished report to the Environmental Protection Agency.

Appendix 1 Distribution map of coastal lagoons in Tacumshin Lake SAC



Appendix 2 Site report

The following is the site account from Oliver (2007)

Code¹	Name
IL007	Tacumshin Lake

¹Code is that used in Oliver (2007).



Conservation Designation: Tacumshin Lake SAC 000709, SPA 004092, pNHA 000709

General description:

Large (430ha) natural sedimentary lagoon with a sand/shingle barrier. In total area this is the largest Irish lagoon but is currently drained and partly dry in summer. A natural outlet has existed intermittently but seals naturally. The substrate is soft sandy mud with gravel near the barrier. Surrounding land is flat and consists of arable fields and pasture. Freshwater enters by several small streams and leaves by the outlet pipes and by seaward percolation through the barrier. Washover occurs in the western sector. Much of the lake bed was exposed during the summer of 1996 following installation of pipes, but water was present to 1m depth by October. Salinity at this time was 8-19‰ on the eastern shore and 3-18‰ in artificial channels near the barrier. Water levels have been monitored recently in an attempt to establish optimum acceptable levels in order to preserve its conservation value.

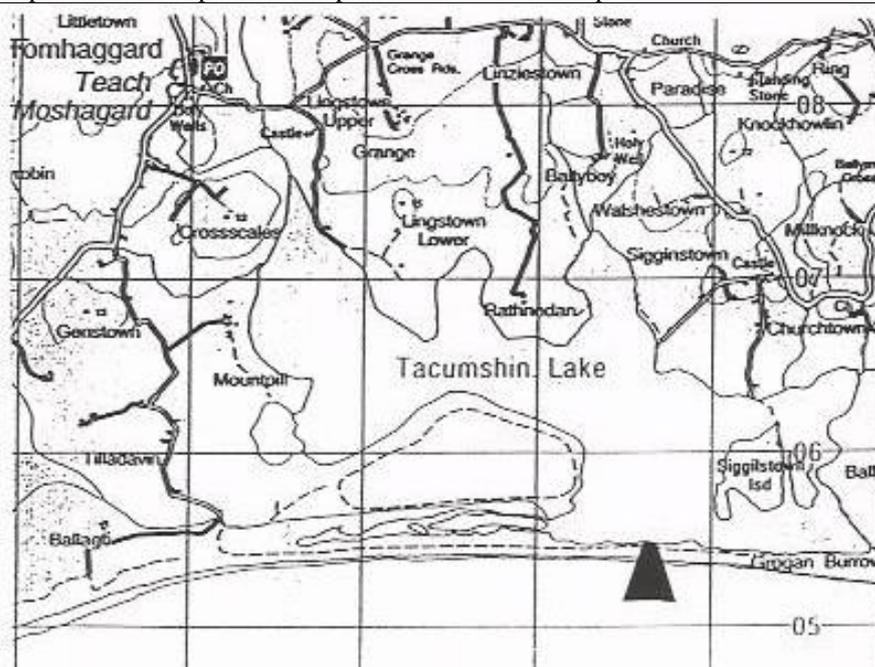


Figure 7.1 Location of map of Tacumshin

Tacumshin Lake was surveyed in 1996 for vegetation (Hatch 1996, Hatch & Healy 1998), aquatic fauna (Healy & Oliver 1996, Oliver & Healy 1998) and ecotonal coleoptera (Good 1996, Good & Butler 1998). Results of these surveys are summarised by Healy *et al.* (1997a,b,c), Healy & Oliver (1998) and Healy (1999, 2003).

Stations used for faunal sampling are not necessarily the same as those used for vegetation or ecotonal coleoptera.

Flora

This large site was surveyed in 1996 by transects only. Five transects were carried out at the lagoon itself and one at a channel at the western end of the site. This is one of six Irish sites at which *Chara canescens* has been recorded since 1970. This rare charophyte was found on this occasion growing sparsely in a northern bay. It was also found in a western channel during a previous site visit. Its presence alone is reason enough to regard Tacumshin Lake as a valuable site. *Ruppia c.f. maritima* was found at four out of five lagoon transects. It grows in occasional dense beds within 50 metres of the barrier shore. *Potamogeton pectinatus* was found at the two northern transects and in a western channel, forming more or less dense beds at all of these. A previous site visit found *Potamogeton pusillus*, *Zannichellia palustris*, *Myriophyllum spicatum* and *Ranunculus baudotii* at low salinities (0-4 parts per thousand) in western and north western channels amongst swamp vegetation. The most notable feature of the marginal vegetation is the extent of swamp species. *Phragmites australis* and *Schoenoplectus* beds fill the two north western bays and much of the south western area. These species and *Scirpus maritimus* fringe much of the north shore and are again extensive in the north central and the north eastern bayheads.

(Previous records for this site include *Lamprothamnion papulosum* and *Zostera* but neither of these has been recorded recently).

Chara canescens was recorded in **eight lagoons** during the surveys - North Slob, Lady's Island L., and Tacumshin L., Co. Wexford, L. Gill, Co. Kerry, L. Murree, Co. Clare, Tanrego, Co. Sligo and Durnesh L. and Inch L., Co. Donegal (Hatch & Healy, 1998; Roden, 1999; Roden 2004). It was also recorded at Shannon Lagoon in 1996 (Hatch and Healy 1998), but not refound at that site in 2003 (Roden 2004). This species is listed in the Red Data Book for Britain and Ireland (Stewart and Church 1992). Although recorded from several European countries it is believed to be declining. It is believed to be extinct in Holland, and there are only a few records from the U.K. since 1960. These Irish locations are therefore very important in European terms.

Ruppia spp. are the most characteristic aquatic plant taxa of Irish coastal lagoons. The species are hard to distinguish when not flowering, and remain uncertain at some sites, but *Ruppia* of one species or the other (*R. maritima*, *R. maritima* var *brevirostris*, *R. cirrhosa*) was found at 62 of the 87 lagoons (71.3%) surveyed, and is one of the most useful indicators of coastal lagoon status. *Ruppia maritima* appears to be the more common of the species and was found at 41 of the lagoons surveyed.

Fauna

Positions of sampling stations are shown in Figure 7.1. and details are given in Table 7.1. Among 40 taxa recorded (Table 7.2), 38 are identified to species. Four of these are listed as lagoonal specialists in Britain and two others are on a proposed list for Ireland (Oliver and Healy 1998). Benthic species were probably undersampled and

only small fish were collected because fyke nets were not used at this site due to low water levels.

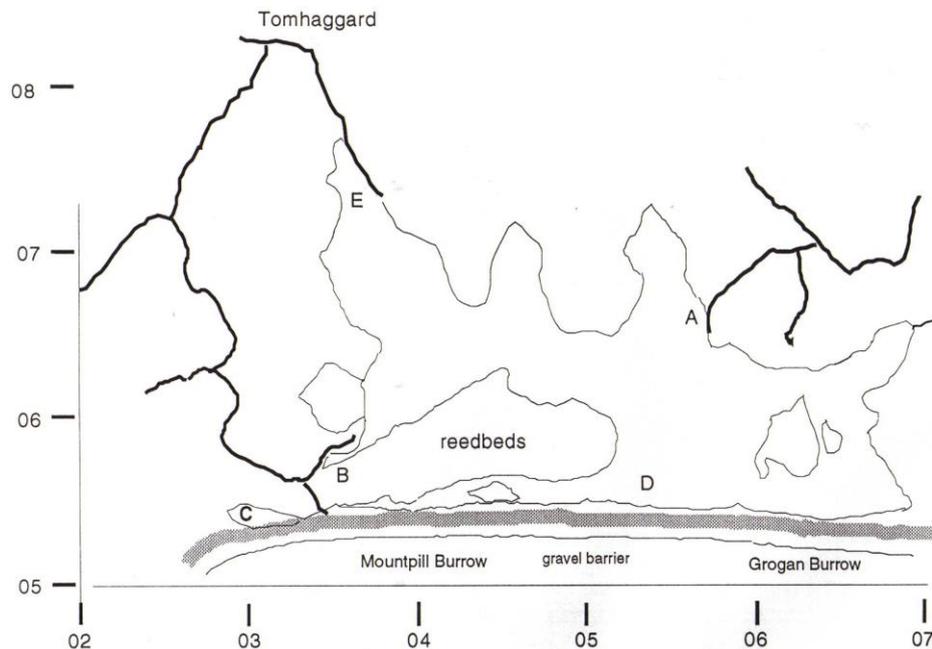


Figure 7.2 Sampling stations used at Tacumshin

Table 7.1 Positions of sampling stations in Tacumshin Lake, with sampling date, salinity, depth of water and type of substratum. * sampled in June but dry in October.

	Station A	Station B	Station C	Station D	Station E*
GPS position	T 0569	T 0345	T 0295	T 0599	T 035
	0666	0565	0542	0548	075
Sampling dates	1-3/10/96	1-3/10/96	1-3/10/96	1-3/10/96	1/7/96
Salinity (psu)	8	3-5	18	19	0
Depth (cm)	0-60	0-150	0-60	0-20	
Substratum	Silty sand, mud and occasional stones.	Sand, gravel, mud	Fine sand and silt, occasional stones.	Fine silty sand and soft mud.	

Lekanesphaera hookeri is a common lagoonal isopod crustacean, found at 37 of the 87 lagoons surveyed (42.5%).

Palaemonetes varians Decapod crustacean listed as a lagoonal specialist in the U.K. by Barnes (1989) and Bamber (1997), but apparently is no longer regarded as such. Although found in estuaries, this species appears to be far more characteristic of lagoons in Ireland, found in 64 of the 87 lagoons surveyed (73.6%) and may require a lagoonal environment for reproduction. Therefore, it remains on the proposed list of lagoonal specialists for Ireland.

Table 7.2 Aquatic Fauna Recorded at Tacumshin Lake, Co. Wexford. July and October, 1996. L.T. = light trap; () = records from July. + = present, r = rare, o = occasional, c = common, a = abundant. Text in bold indicates lagoonal specialist or notable species.

Taxa	Sampling Stations							
	A	L.T.A	B	L.T.B	C	L.T.C	D	E
Annelida								
<i>Hediste diversicolor</i>	c				c		+	
<i>Pomatoceros triqueter</i>					shells			
Crustacea								
Cirripedia <i>Balanus improvisus</i>					shells			
Mysidacea <i>Neomysis integer</i>		1	1 (c)		1			
Isopoda <i>Lekanesphaera hookeri</i>	c	>100	+	<100	c	2		(+)
<i>Asellus aquaticus</i>								(+)
Amphipoda <i>Gammarus salinus</i>	+	+	+		+	+		
Decapoda <i>Palaemonetes varians</i>	+	?	a	>100	c	2		
Acarina					+			
Insecta								
Odonata <i>Ischnura elegans</i>	1		+		a			
Hemiptera <i>Gerris odontogaster</i>					+			
<i>G. thoracicus</i>					+			
<i>Notonecta glaucum</i>			+		+			
<i>N. viridis</i>		+	+		a			
<i>Plea leachi</i>			+		1			
Corixidae	+		a	>100	a	c100		
<i>Callicorixa praeusta</i>	+	+	+		c			(a)
<i>Corixa punctata</i>			(+)					(a)
<i>C. panzeri</i>		+	+		+	+		
<i>Hesperocorixa linnaei</i>					+			
<i>Sigara dorsalis</i>			a	+	+			(+)
<i>S. concinna</i>					+	+		
<i>S. stagnalis</i>	+		a	a	+	a		
Coleoptera			+		+			(+)
<i>Colymbetes fuscus</i>			+					
<i>Enochrus halophilus</i>	+							
<i>Gyrinus caspius</i>			+					
<i>Hydrobius fuscipes</i>								(+)
<i>Hydroporus planus</i>			+					
<i>Hygrotus impressopunctatus</i>	+							
<i>H. inaequalis</i>			+					
<i>Laccophilus minutus</i>			+					
<i>Noterus clavicornis</i>	+		+					
<i>Rhantus frontalis</i>	+		+			+		
Diptera Chironomidae	c		+		a		+	(+)
Mollusca								
Prosobranchia <i>Hydrobia ventrosa</i>					5			
<i>Potamopyrgus antipodarum</i>	c		3		11			(+)
Pulmonata <i>Lymnaea peregra</i>			+					(+)
<i>L. palustris</i>			+					
<i>Planorbis leucostoma</i>			+					(+)
Bivalvia <i>Cerastoderma glaucum</i>	shells							
Teleostei								
<i>Gasterosteus aculeatus</i>	a	c100	+	15	a	>100	?	(+)
<i>Pungitius pungitius</i>			1					

Notonecta viridis Hemipteran insect (back-swimmer) recorded on the east coast at Kilcoole and the North Slob, on the south coast at Lady's Island L., Tacumshin L., Ballyteige, Clogheen/White's Marsh and Kilkeran L. and also on the west coast at Reenydonegan, Co. Cork and L. Donnell, Co. Clare. A rare brackish water species in

Ireland. According to Southwood and Leston (1959), it was recorded only for Wexford and North Kerry. Recorded previously in Lady's Island L (Healy *et al.* 1982) in Lady's Island L. and the North Slob by Galvin (1992) and from the Dingle Peninsula by McCarthy and Walton (1980). *N. viridis* is found at inland sites in the U.K. but appears to be largely restricted to lagoons in Ireland, and is proposed as a lagoonal specialist for Ireland.

Plea leachi has been recorded from Ballyteige, Tacumshin and The North Slob (Co. Wexford) and from Kilcoole (Co. Wicklow), and curiously from two sites in Galway (Dorus Lakes, Loch an Chaorain). Recorded previously from Tacumshin and Ballyteige (Galvin 1992). Otherwise appears to be rare, but is small and could be overlooked. Halbert (1935) recorded it from L. Gill (Co. Kerry) and described it as widespread, but local, usually "in stagnant water near the coast". Proposed as a lagoonal specialist for Ireland.

Enochrus halophilus Water-beetle recorded only at this site during the lagoon surveys and previously from samples collected from L. Beg, Co. Cork in 1992. One specimen was found in L. Murree by Pybus and Pybus (1980). There appear to be no other recent records.

Ochthebius marinus Water-beetle identified from Tacumshin L. in 1996, by Galvin from Lady's Island and Tacumshin in 1991, and at Clogheen/White's Marsh, Co. Cork in 2003. Only recorded from one 10-km square in Ireland by Foster *et al.* (1992). Four recent records from Co. Down (Nelson *et al.* 1998).

Sigara stagnalis Hemipteran insect (water-boatman). A common lagoonal specialist found at 36 of the 87 (41.4%) lagoons surveyed.

Hydrobia ventrosa. Gastropod mollusc commonly found in brackish lagoons and ditches and generally not on the open coast. Recorded at 18 of the 87 (20.7%) lagoons surveyed up to 2006.

Cerastoderma glaucum Bivalve mollusc. A common lagoonal specialist found at 30 of the 87 lagoons (34.5%) surveyed.

Shells of *Cerastoderma glaucum* were present at station A but no live specimens could be found. A thriving population was present in 1977 in an area of the southeast known locally as the "cockle lake", and live specimens were taken at station A in 1991 (Galvin 1992).

Ecotonal coleoptera

Only one indicator species was recorded in Tacumshin Lake in 1996 (Good 1996, Good & Butler 1998), and based on ecotonal coleoptera, the site is regarded as of **low conservation value**.

Summary

Tacumshin Lake is a very large **natural sedimentary lagoon**. The lagoon and barrier are good examples of geomorphological types and there is a long history of scientific investigations. Despite drainage attempts, it is still largely natural, although current management practices are controversial and effective solutions to the conflicting interests are subject to financial constraints. This is one of only 8 lagoons in the country where the rare charophyte *Chara canescens* is known. *Lamprothamnion papulosum* was recorded here previously. The aquatic fauna is rich with 40 taxa recorded of which 7 are lagoonal specialists. The assemblage typifies a low salinity lagoon with a consistently high input of freshwater, and few opportunities for colonisation from the sea. Overall conservation value is rated as exceptional.

Overall Conservation Value = Exceptional

Conservation Status Assessment (from Oliver 2007)

Impacts	Severe drainage and major modification of hydrology. Disturbance from recreational activities. Invasion by exotics.
Conservation Status	Unfavourable-BAD

Further Information

Tacumshin Lake was surveyed in 1996 for vegetation (Hatch 1996, Hatch & Healy 1998), aquatic fauna (Healy & Oliver 1996, Oliver & Healy 1998) and ecotonal coleoptera (Good 1996, Good & Butler 1998). Results of these surveys are summarised by Healy *et al.* (1997a,b,c), Healy & Oliver (1998), and Healy (1999, 2003). Included in a biological classification of Irish coastal lagoons (Oliver 2005) and in the Conservation Status Assessment (Oliver 2007).

References:

- Bamber, R.N. 1997. Assessment of saline lagoons within Special Areas of Conservation. *English Nature Research Reports* No. 235.
- Barnes, R.S.K. 1989. Coastal lagoons of Britain: an overview and conservation appraisal. *Biological Conservation* **49**: 295–313
- Foster, G.N., Nelson, B.H., Bilton, D.T., Lott, D.A., Merritt, R., Weyl, R.S. & Eyre, M.D. 1992. A classification and evaluation of Irish water beetle assemblages. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **2**: 185-208.
- Galvin, P. 1992. *The ecology of the brackish-water lagoons of Wexford and east Cork*. MSc thesis, University College, Dublin.
- Good, J.A. 1996. *Coastal lagoons in the Republic of Ireland: Ecotonal Coleoptera (Staphylinidae and Carabidae)*. Dúchas, Dublin.
- Good, J.A. & Butler, F.T. 1998. Coastal lagoon shores as a habitat for Staphylinidae and Carabidae (Coleoptera) in Ireland. *Bulletin of the Irish Biogeographical Society*. **21**: 22-65.
- Halbert, J.N. 1935. A list of Irish Hemiptera (Heteroptera and Cicadina). *Proc. R. Ir. Acad.* **97B**: 33-51.
- Hatch, P. 1996. *A survey of the vegetation of Irish coastal lagoons. 1996*. Unpubl. Report to NPWS. Dublin
- Hatch, P. & Healy, B. 1998. Aquatic vegetation of Irish coastal lagoons. *Bulletin of the Irish Biogeographical Society*. **21**: 2-21.
- Healy, B. 1999. *Survey of Irish coastal lagoons. 1996 and 1998. Vol. 1 Part 1. Background, description and summary of the surveys*. Dúchas, Dublin.
- Healy, B. 2003. Coastal Lagoons. In: *Wetlands of Ireland*. R. Otte (ed). Chapter 4. University College Dublin Press. Dublin. 44-78.
- Healy, B. & G.A. Oliver. 1996. *A survey of Irish coastal lagoons: Aquatic Fauna*. Unpublished report for Dúchas, The Heritage Service. Dublin.
- Healy, B. & Oliver, G.A. 1998. Irish coastal lagoons: summary of a survey. *Bulletin of the Irish Biogeographical Society*. **21**: 116-50.
- Healy, B., Bates, R. & McGrath, D. 1982. Marine Fauna of Co. Wexford - 5. Lady's Island Lake. *Irish Naturalists' Journal* **20**: 509-560.
- Healy, B., Oliver, G.A., Hatch, P. & Good, J.A. 1997a. *Coastal lagoons in the Republic of Ireland. Vol. 1. Background, outline and summary of the survey*. Report to the National Parks and Wildlife Service, Dublin.
- Healy, B., Oliver, G.A., Hatch, P. & Good, J.A. 1997b. *Coastal lagoons in the Republic of Ireland. Vol. 2. Results of site surveys Parts 1-20*. Report to the National Parks and Wildlife Service, Dublin.
- Healy, B., Oliver, G.A., Hatch, P. & Good, J.A. 1997c. *Coastal lagoons in the Republic of Ireland. Vol. 3. Inventory of lagoons and saline lakes*. Report to the National Parks and Wildlife Service, Dublin.
- McCarthy, T.K. & Walton, G.A. 1980. *Sigara selecta* (Fieb.) (Heteroptera: Corixidae) new to Ireland, with notes on water bugs recorded from the Dingle Peninsula. *Irish Naturalists' Journal* **20**: 64-6.
- Nelson, B., Foster, G., Weyl, R. & Anderson, R. 1998. The distribution of aquatic Coleoptera in Northern Ireland. Part 2: Families Hydraenidae, Helophoridae, Hydrochidae, Hydrophilidae, Elmidae and Dryopidae. *Bulletin of the Irish Biogeographical Society*. **22**: 128-193.
- Oliver, G.A. 2005. *Seasonal changes and Biological Classification of Irish Coastal Lagoons*. PhD Thesis. U.C.D., Dublin.
- Oliver, G.A. 2007. Conservation status report: Coastal Lagoons (1150). Unpublished report to the National Parks and Wildlife Service, Dublin.

- Oliver, G.A. and Healy, B. 1998 Records of aquatic fauna from coastal lagoons in Ireland. *Bulletin of the Irish Biogeographical Society*. **21**: 66-115.
- PAT PARLE Water level study ??????????????
- Pybus, C. and Pybus, M.J. 1980. An ecological study of Lough Murree, a brackish water lake in County Clare. *Proceedings of the Royal Irish Academy* **80B**: 367-384.
- Roden, C. 2004. *Report on the sub littoral flora and vegetation of nine coastal lagoons..* Dúchas, Dublin.
- Stewart, N.F. & Church, J.M. 1992. *Red Data Books of Britain and Ireland. Charophytes.* Joint Nature Conservation Committee and Office of Public Works, Dublin.
- Southwood, T.R.E. & Leston, D. 1959. *Land and water bugs of the British Isles.* Wayside and Woodland Series. Warne & Co. London. 436 pp.