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Integrated Water Resources Management in Myanmar. Assessing ecological status in Inlay Lake.

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REPORT

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Abstract

The report is one of the deliverables of the project *Integrated water resources management – Institutional building and training*. The main purpose of the report has been to achieve improved knowledge about aquatic biodiversity and water chemistry in Inlay Lake, and to give an example for assessing the ecological status. In addition, to develop preliminary recommendations for a monitoring programme for Inlay Lake, physical measurements, water and phytoplankton samples and aquatic macrophytes were collected at several sites in different parts of the lake in 2014-2015. Inlay Lake can be characterized as a mid-altitude, very large and very shallow, calcareous, clear lake, and the nutrient concentration show mesotrophic to semi-eutrophic conditions. Preliminary ecological status for phytoplankton and aquatic macrophytes are suggested based on different indices. Preliminary recommendations for a monitoring programme for Inlay Lake are included.

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3. Karakterisering	3. Characterisation
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Integrated Water Resources Management in Myanmar

Assessing ecological status in Inlay Lake

Preface

Inlay Lake, a freshwater lake located in the Nyaungshwe Township of Taunggyi District of Shan State, is of particular importance to the Myanmar people due to its cultural significance, beauty, and aquatic biodiversity present. The close relationship between people and the lake has been described as a symbiosis, and the lake is accepted as a "Man and the Biosphere Area (MAB)". The lake suffers from environmental effects of increased population and rapid growth in both agriculture and tourism. Assessing the ecological status of the lake requires knowledge of ecological water quality criteria, and in this project the EU Water Framework Directive is used as a baseline for depicting adapted ecological water quality criteria.

The IWRM project is a collaboration between the Norwegian Institute for Water Research (NIVA) and the Forest Department, Ministry of Natural Resources and Environmental Conservation (MONREC). The project leader at MONREC is U Zaw Win Myint, director of Watershed Management Division, Forest Department, and researcher Ingrid Nesheim is the project leader at NIVA. The steering group has representatives from Forest Department (FD), Irrigation and Water Utilization Management Department (IWUMD), the Directorate for Water Resources and Improvement of River Systems (DWIR) and NIVA. The project leaders have a close dialogue with the National Water Resources Committee in Myanmar. The project is part of the Norwegian – Myanmar Bilateral Environment Programme, 2015-2018, and is funded by the Norwegian embassy in Yangon. The development goal of the IWRM project is to make a significant and positive contribution to the implementation and functioning of Integrated Water Resources Management in Myanmar, for inland waters at the national level. The objective is to establish methods and standards for Integrated Water Resources Management and to support initiation of the implementation process.

The current report is a deliverable under the output: 'Pilot Case study 6: Monitoring programme for Inlay Lake'. The report presents the approach and the method for ecological status classification according to the EU WFD and provides a preliminary status classification for Inlay Lake based on field work in 2014 and 2015. All field surveys and analyses have been conducted by Andreas Ballot, Marit Mjelde and Thida Swe. The chemical analyses have been conducted at NIVA's chemical laboratory in Oslo, Norway, however future chemical analysis will take place at the new water laboratory at the Forest Research Institute, Yezin, Myanmar. This report was prepared by Andreas Ballot and Marit Mjelde (NIVA), and Thida Swe (Forest Research Institute, Myanmar).

Oslo, 31 October 2018

Andreas Ballot

စကားချီး

ယဉ်ကျေးမှုအမွေအနှစ်များ ကြွယ်ဝမှု၊ သာယာလှပမှုနှင့် ဇီဝမျိုးစုံမျိုးကွဲများ ပေါများမှုတို့ကြောင့် ရှမ်းပြည်နယ်၊ ညောင်ရွှေမြို့နယ်အတွင်းရှိ အင်းလေးကန်သည် နိုင်ငံသားတို့အတွက် အရေးပါသည့် ဒေသတစ်ခု ဖြစ်ပါသည်။ အင်းလေးကန်ဒေသသည် လူနှင့် ပတ်ဝန်းကျင် ယှဉ်တွဲနေထိုင်သည့် ပြယုဂ်တစ်ခု ဖြစ်သောကြောင့် ယူနက်စကိုမှ လူသားနှင့် ဇီဝအဝန်းဒေသ (Man and the Biosphere Area -MAB) ဟု သတ်မှတ်ခြင်းခံရသည်။ သို့သော်လည်း လူဦးရေ တိုးပွားလာမှု၊ စိုက်ပျိုးရေးနှင့် ခရီးသွားလာရေး လုပ်ငန်း များ ဖွံ့ဖြိုးတိုးတာလာမှုတို့ကြောင့် အင်းလေးကန်၏ ပတ်ဝန်းကျင်အနေအထားများ ယိုယွင်းလာလျက် ရှိပါသည်။ အင်းလေးကန်၏ ဂေဟအဆင့်အတန်း (Ecological Status) ကို သတ်မှတ်ရန်အတွက် ရေ၏ ဂေဟစနစ်ဆိုင်ရာ အရည်အသွေးအား သတ်မှတ်သည့် စံများရှိရန် လိုအပ်ပါသည်။ ဤအစီရင်ခံစာတွင် အင်းလေးကန်၏ ဂေဟစနစ်ဆိုင်ရာ ရေအရည်အသွေးနှင့်ဆိုင်သည့် စံများ သတ်မှတ်ဖော်ပြရာ၌ ဥရောပ သမဂ္ဂမူဘောင် (EU Water Framework Directive) ကို အခြေခံ၍ ဆောင်ရွက်ထားပါသည်။

ရေသယံဇာတ ဘက်စုံစီမံအုပ်ချုပ်လုပ်ကိုင်ခြင်းနှင့် စွမ်းဆောင်ရည်မြှင့်တင်ခြင်း စီမံကိန်းသည် နော်ဝေနိုင်ငံရေသုတေသနဌာန (Norwegian Water Research Institute - NIVA) နှင့် မြန်မာနိုင်ငံ သယံဇာတနှင့် သဘာဝပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဝန်ကြီးဌာနတို့၏ ပူးပေါင်းဆောင်ရွက်မှု လုပ်ငန်း တစ်ရပ် ဖြစ်ပါသည်။ အဆိုပါစီမံကိန်းသည် နော်ဝေ–မြန်မာ နှစ်နိုင်ငံ ပတ်ဝန်းကျင်ကဏ္ဍ ပူးပေါင်းဆောင်ရွက်မှု အစီအစဉ် (၂၀၁၅–၂၀၁၈) တွင် ပါဝင်သည့် စီမံကိန်း ၃ ခု အနက်မှ တစ်ခုဖြစ်ပြီး နော်ဝေနိုင်ငံ၊ နိုင်ငံခြားရေး ဝန်ကြီးဌာနမှ ရန်ပုံငွေထောက်ပံ့ပေးသည်။ မြန်မာနိုင်ငံ၊ သယံဇာတနှင့် သဘာဝပတ်ဝန်းကျင် ထိန်းသိမ်းရေး ဝန်ကြီးဌာန၊ သစ်တော ဦးစီးဌာနဘက်မှ ညွှန်ကြားရေးမှူး၊ ရေဝေရေလဲဒေသ အုပ်ချုပ်ရေးဌာန၊ ဦးဇော်ဝင်းမြင့် က စီမံကိန်း တာဝန်ခံ အဖြစ် ဆောင်ရွက်ပြီး နော်ဝေနိုင်ငံ၊ ရေသုတေသနဌာနမှ သုတေသနပညာရှင် Dr. Ingrid Nesheim က စီမံကိန်း လုပ်ငန်း ခေါင်းဆောင်အဖြစ် ဆောင်ရွက်လျက်ရှိပြီး သစ်တောဦးစီးဌာန၊ ရေအရင်းအမြစ်နှင့် မြစ်ချောင်းများ ဖွံ့ဖြိုးတိုးတက်ရေး ဦးစီးဌာနတို့မှ တာဝန်ရှိပုဂ္ဂိုလ်များအပြင် နော်ဝေနိုင်ငံ ရေသုတေသနဌာနမှ ပညာရှင်များက အဖွဲ့ဝင်အဖြစ် ပါဝင်ကြသည်။ စီမံကိန်း တာဝန်ခံများအနေနှင့် မြန်မာနိုင်ငံ အမျိုးသားရေသယံဇာတကော်မတီ နှင့်လည်း နီးကပ်စွာ ပူးပေါင်းဆောင်ရွက်လျက်ရှိသည်။ ရေသယံဇာတ ဘက်စုံစီမံအုပ်ချုပ်လုပ်ကိုင်ခြင်းနှင့် စွမ်းဆောင်ရည် မြှင့်တင်ခြင်းစီမံကိန်း၏ ရည်ရွယ်ချက်ပန်းတိုင်းမှာ နိုင်ငံ၏ ရေသယံဇာတမူဘောင်ဆိုင်ရာ ညွှန်ကြားချက်များနှင့်အညီ ရေသယံဇာတများအား စီမံအုပ်ချုပ်လုပ်ကိုင်နိုင်ရန်ဖြစ်ပြီး ရေတိုရည်ရွယ်ချက်မှာ မြန်မာနိုင်ငံအတွင်း ဘက်စုံ ရေသယံဇာတ စီမံခန့်ခွဲမှုဆိုင်ရာ လုပ်ထုံးလုပ်နည်းနှင့်စံများ ရေးဆွဲသတ်မှတ်ရန်နှင့် လက်တွေ့ အကောင်အထည်ဖော်မှု လုပ်ငန်းများ စတင်နိုင်ရေးအတွက် အထောက်အကူပြုနိုင်ရန် ဖြစ်သည်။

ဤအစီရင်ခံစာရေးသားတင်ပြခြင်းသည် စီမံကိန်းမှဆောင်ရွက်လျက်ရှိသည့် လုပ်ငန်းခေါင်းစဉ်အမှတ် (၆) ဖြစ်သော "အင်းလေးကန်၏ရေအရည်အသွေးအား စောင့်ကြည့်ဆန်းစစ်ခြင်း" ၏ အောက်တွင် ပါဝင်သည့် ဆောင်ရွက်ရမည့် လုပ်ငန်းတစ်ရပ်ဖြစ်ပါသည်။ ဤအစီရင်ခံစာတွင် ရေ၏ ဂေဟစနစ်ဆိုင်ရာ အရည်အသွေး အဆင့်အတန်းအား ဥရောပသမဂ္ဂရေသယံဇာတမူဘောင်ကို အခြေခံ၍သတ်မှတ်သည့် နည်းစနစ်များကို ဖော်ပြထားပြီး အင်းလေးကန်၏

ရေအရည်အသွေးအား ၂၀၁၄ ခုနှစ်မှ ၂၀၁၅ ခုနှစ်အထိ တိုင်းတာစိစစ် ဖော်ပြ ထားပါသည်။ ကွင်းဆင်းရေနမူနာကောက်ယူခြင်းနှင့် ဓါတ်ခွဲစမ်းသပ်ခြင်းတို့အား Andreas Ballot၊ Marit Mjelde နှင့် ဒေါ်သီတာဆွေတို့က ဆောင်ရွက်ခဲ့ပြီး ရေ၏ ဓါတုဗေဒဆိုင်ရာ အရည်အသွေး ဓါတ်ခွဲစမ်းသပ်မှုများအား နော်ဝေနိုင်ငံ အော်စလိုမြို့ရှိ ရေသုတေသနဌာန ဓါတ်ခွဲခန်းတွင် ဆောင်ရွက်ခဲ့ပါသည်။ အနာဂါတ်တွင် အဆိုပါလုပ်ငန်းစဉ်ကို နေပြည်တော် သစ်တောသုတေသနဌာန (ရေဆင်း) ရှိ ရေဓါတ်ခွဲခန်းအသစ်တွင် ဆောင်ရွက်နိုင်တော့မည် ဖြစ်ပါသည်။ ဤအစီရင်ခံစာအား နော်ဝေနိုင်ငံ ရေသုတေသနဌာနမှ Andreas Ballot၊ Marit Mjelde နှင့် မြန်မာနိုင်ငံ သစ်တောသုတေသနဌာနမှ ဒေါ်သီတာဆွေတို့မှ ပူးပေါင်းရေးသား ပြုစုထားခြင်း ဖြစ်ပါသည်။

၂၀၁၈ ခုနှစ် အောက်တိုဘာလ ၃၁ ရက်

Andreas Ballot

Contents

Summary

This report is one of the deliverables of the project *Integrated water resources management – Institutional building and training*, a collaboration between the Ministry of Natural Resources and Environmental Conservation (MONREC, previously MOECAF) and the Norwegian Institute for Water Research (NIVA) under the Norwegian - Myanmar Bilateral Environment Programme 2015-2018.

Inlay Lake is the second largest natural lake in Myanmar and very important for the people of Myanmar. The lake is however negatively affected by increasing human population and rapid growth in both agriculture and tourism, with aquatic biology under pressure and action needed. Before decisions about which actions to take can be made, sufficient data need to be collected as a basis for status assessments.

The main purpose of this report is to improve knowledge about aquatic biodiversity and water chemistry in Inlay Lake, and to give a preliminary assessment of the ecological status. In addition, the report's purpose is to present preliminary recommendations for a monitoring programme in the Lake.

At 14 different lake sites, physical measurements, water samples and phytoplankton samples were collected. In addition, aquatic macrophytes were surveyed at the same sites. The investigation took place in November 2014, February and November 2015 and March 2017. Some results from water samples taken from inflowing rivers and from the outlet are included.

Inlay Lake can be characterised as a mid-altitude, very large and very shallow, calcareous, clear lake. The nutrient concentrations in the lake show mesotrophic to semi-eutrophic conditions, and both phosphorous and nitrogen concentrations are generally higher in the inlet rivers.

In 2014-2017, altogether 269 phytoplankton taxa were identified at the three main sampling sites. As a number of taxa could be determined to genus level only, the number of taxa present in Inlay Lake is supposedly higher. The phytoplankton biomass ranged from 0.44 to 5.04 mg/l, which indicates a range from very good to poor status of the lake's phytoplankton. Without aquatic macrophytes the phytoplankton biomass would most likely be much higher. Removal of large amounts of aquatic macrophytes from Inlay Lake would probably lead to an increased growth of phytoplankton, which would have negative effects on the water quality of the lake.

The shallowness and clear water conditions of Inlay Lake support a strong growth of aquatic macrophytes. A total number of 29 species of aquatic macrophytes were recorded in the lake in 2014-2017. Species frequency and abundance differed from season to season, and from year to year. However, in both years and seasons, the elodeids *Nechamandra alternifolia* and *Potamogeton lucens,* and the lemnid *Eichornia crassipes* dominated the aquatic macrophyte vegetation.

For assessing ecological status for macrophytes, we tested the three possible indices; i.e. the Norwegian trophic index (TIc), Relative abundance index (RA-index) and Submerged macrophyte coverage index (SMC index). The ecological status assessment of Inlay lake varies considerably, depending on the various indices. Macrophyte cover, particularly in shallow lakes like Inlay lake, is important for maintaining the clear water state. Since the nutrient input to the lake is high, decreased macrophyte cover will lead to an increased phytoplankton biomass and decreased water clarity. At this stage, we therefore suggest to emphasize the submerged cover index, maybe in combination with Relative abundance index. However, the suitability of different indices for Myanmar lakes have to be evaluated further, and boundaries exclusively for Myanmar have to be developed when more data from the country are available. Based on the preliminary species sensitivity for Myanmar species, and using the suggested Norwegian trophic index and boundaries, the status of aquatic macrophytes in Inlay Lake is classified as poor. The status seems to become worse from November 2014 to November 2015, however, still in the same status class.

To assess ecological status of Inlay lake, we recommend a monitoring programme with the biological elements phytoplankton (including chlorophyll) and aquatic macrophytes. In addition, the following physico-chemical parameters should be included: oxygen, pH, conductivity, calcium, colour, turbidity, total phosphorous (TP), PO_4, total nitrogen (TN), NO_3, NH_4, and total organic carbon (TOC). The original number of 14 sampling localities from 2014-2017 can be reduced to 6 localities for water chemistry and phytoplankton, while all localities should be maintained for aquatic macrophytes.

To detect the effects from use of pesticides in the floating gardens, we suggest sediment sampling once a month in the period when farmers spray with pesticides. To detect metal pollution from small industries, sampling close to the outlet and downstream the industries are needed. Sewage from villages will mainly refer too nutrient and bacteria impact. Monitoring of bacteria levels need to occur regularly, but more frequent in the dry, summer season when particularly high levels of bacteria can be expected.

အစီရင်ခံစာအကျဉ်းချုပ်

ဤအစီရင်ခံစာကို နော်ဝေ–မြန်မာနှစ်နိုင်ငံ ပတ်ဝန်းကျင်ဆိုင်ရာ ပူးပေါင်းဆောင်ရွက်မှု အစီအစဉ် (၂၀၁၅–၂၀၁၈) တွင် ပါဝင်သော စီမံကိန်းတစ်ခုဖြစ်သည့် ရေသယံဇာတဘက်စုံစီမံအုပ်ချုပ်လုပ်ကိုင်ခြင်းနှင့် စွမ်းဆောင်ရည်မြင့်တင်ခြင်း စီမံကိန်းမှ ပြုစုတင်ပြခြင်း ဖြစ်ပါသည်။ အဆိုပါစီမံကိန်းကို မြန်မာနိုင်ငံ သယံဇာတနှင့် သဘာဝပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဝန်ကြီးဌာနနှင့် နော်ဝေနိုင်ငံရေသုတေသနဌာနတို့မှ ပူးပေါင်းဆောင်ရွက်လျက် ရှိပါသည်။

အင်းလေးကန်သည် မြန်မာနိုင်ငံတွင် ဒုတိယအကြီးဆုံးသဘာဝရေကန်တစ်ခုဖြစ်ပြီး နိုင်ငံသားတို့ အတွက် လူမှုစီးပွားရေးနှင့် ယဉ်ကျေးမှုဆိုင်ရာ အရေးပါသည့် ပြယုဂ်တစ်ခုဖြစ်ပါသည်။ သို့သော် အင်းလေးကန် ဝန်းကျင်အတွင်း လူဦးရေတိုးပွားလာမှု၊ စိုက်ပျိုးရေးနှင့် ကမ္ဘာလှည့်ခရီးသွားလုပ်ငန်း ဖွံ့ဖြိုး တိုးတက်မှုတို့ကြောင့် ရေအရည်အသွေးနှင့် ကန်၏အနေအထား ယိုယွင်းပျက်စီးလာခဲ့ပါသည်။ အထူးသဖြင့် ရေအတွင်းရှိ ဇီဝမျိုးစုံမျိုးကွဲများအပေါ်တွင် ဖိအားများ ကျရောက်လျက်ရှိပြီး ထိန်းသိမ်းပြုပြင်ရန်လိုအပ်လျက် ရှိသည်။ မည်သည့် ထိန်းသိမ်းပြုစုခြင်းလုပ်ငန်းများဆောင်ရွက်ရမည်ကို သိရှိနိုင်ရန်အတွက် ရေနှင့် ပတ်သက်သည့် သတင်းအချက်အလက်များ ကောက်ယူစုစည်း၍ ဆန်းစစ်ပြီးလျှင် ရေ၏အခြေအနေကို ဦးစွာသိရှိစေရေး ဆောင်ရွက်ရန် လိုအပ်ပါသည်။

ဤအစီရင်ခံစာ၏ အဓိကရည်ရွယ်ချက်မှာ အင်းလေးကန်အတွင်းရှိ ဇီဝမျိုးစုံမျိုးကွဲများနှင့် ကန်၏ဂေဟစနစ်အခြေအနေဆန်းစစ်ရရှိချက်များကို တင်ပြရန် ဖြစ်သည်။ ကန်၏ နေရာ (၁၄) ခုတွင် ရူပ ဂုဏ်သတ္တိအခြေအနေအား ကွင်းအတွင်းတိုင်းတာခြင်း၊ ရေနမူနာနှင့် ရေညှိ (Phytoplankton) နမူနာများကို ကောက်ယူစုဆောင်းခြင်းလုပ်ငန်းများ ဆောင်ရွက်ခဲ့ပါသည်။ ထိုနေရာများတွင် ရေပေါင်းပင် (Aquatic Macrophyte) ပေါက်ပွားမှုအခြေအနေကိုလည်း စာရင်းကောက်ယူ စုဆောင်းခဲ့ပါသည်။ အဆိုပါ လုပ်ငန်းများကို ၂၀၁၄ ခုနှစ်နိုင်ဝင်ဘာလတွင်လည်းကောင်း၊ ၂၀၁၅ ခုနှစ် ဖေဖော်ဝါရီလနှင့် နိုဝင်ဘာလများတွင် လည်းကောင်း၊ ၂၀၁၇ ခုနှစ်မတ်လတွင် လည်းကောင်း ဆောင်ရွက်ခဲ့ပါသည်။ ကန်အတွင်းစီးဝင်သောချောင်းများနှင့် အထွက်ချောင်းများအတွင်း ကောက်ယူ စုဆောင်းခဲ့သော ရေနမူနာများ၏ ရလာဒ်များကိုလည်း ထည့်သွင်းဖော်ပြထားပါသည်။

အင်းလေးကန်သည် ကုန်းမြင့်ဒေသတွင်ရှိပြီး ကြီးမားကျယ်ပြန့်၍ ရေတိမ်သည့်အပြင် ရေကြည်လင်၍ထုံးကျောက်ဓါတ်ပျော်ဝင်လျက်ရှိသည့် ကုန်းတွင်းရေကန်အမျိုးအစားဖြစ်ပါသည်။ ကန်အတွင်းရှိရေ၏ အာဟာရဓါတ်ပါဝင်မှုအရ အသင့်အတင့် (Mesotrophic) မှ အနည်းငယ်များသော (semi-eutorphic) အာဟာဓါတ်ပါဝင်မှုအခြေအနေတွင်ရှိကြောင်း တွေ့ရှိရပြီး အင်းလေးကန်အတွင်း စီးဝင်သောချောင်းများအတွင်းရှိ ရေတွင် ယေဘူယျအားဖြင့် နိုက်ထရိုဂျင် နှင့် ဖော့စဖောရပ်စ်ဓါတ်များ ပါဝင်မှုမြင့်မားနေကြောင်း တွေ့ရှိရသည်။

၂၀၁၄ နှင့် ၂၀၁၇ ခုနှစ်များအတွင်း နမူနာအကွက် (၃) ကွက်တွင် ဆန်းစစ်ချက်အရ အင်းလေးကန် အတွင်း ရေညှိ (Phytoplankton) မျိုးပေါင်း (၂၆၉) မျိုး အထိ တွေ့ရှိ မှတ်တမ်းတင်နိုင်ခဲ့သည်။ တွေ့ရှိသော ရေညှိများကို မျိုးစိတ် (Genus) အဆင့်အထိသာ ခွဲခြားနိုင်ခဲ့သောကြောင့် အင်းလေးကန်အတွင်း ရေညှိ မျိုးစိတ်များ မှာ ယခုတွေ့ရှိသော ပမာဏထက်ပိုမို များပြားနိုင်ပါသည်။ ရေညှိပင်များ ပါဝင်ပေါက်ရောက်မှု ဇီဝဒြပ်ထု (Biomass)

အခြေအနေမှာ ရေ ၁ လီတာတွင် ၀.၄၄ မှ ၅.၀၄ မီလီဂရမ် ပါဝင်နေခြင်းက ကန်၏ရေညှိ ပေါက်ပွားမှု အခြေအနေမှာ ကောင်းသည့်အခြေအနေမှ ဆိုးရွားသည့် အခြေအနေ ရောက်ရှိနေကြောင်း ညွှန်ပြနေ ပါသည်။ ရေပေါင်းပင်များ ပေါက်ရောက်မှုမရှိပါက ကန်အတွင်းရှိ ရေညှိပေါက်ရောက်မှုမှာ ယခုအခြေအနေထက် ပိုမိုဆိုးရွားနိုင်ပါသည်။ ထို့ကြောင့် အင်းလေးကန်အတွင်းရှိ ရေပေါင်းပင်များအမြောက်အများ ဖယ်ရှားခြင်းသည် ရေညှိပင်များပေါက်ပွားမှုကိုနှုန်းကို မြင့်မားစေနိုင်ပြီး ကန်၏ ရေအရည်အသွေး အခြေအနေကို ဆိုးကျိုး သက်ရောက်စေနိုင်ပါသည်။

ကန်ရေတိမ်ခြင်းနှင့် ရေကြည်လင်နေခြင်းက ရေပေါင်းပင်များ၏ ပေါက်ရောက်ကြီးထွားမှုကို ကောင်းစွာ အထောက်အကူပြုလျက်ရှိပါသည်။ ၂၀၁၄ ခုနှစ်နှင့် ၂၀၁၇ ခုနှစ်အတွင်း ရေပေါင်းပင် ၂၉ မျိုးကို မှတ်တမ်း တင်နိုင်ခဲ့ပါသည်။ အဆိုပါအပင်များ၏ တွေ့ရှိရသည့် အကြိမ်အရေအတွက်နှင့် ပေါများမှုမှာ ရာသီအလိုက်နှင့် နှစ်အလိုက် ကွဲပြား ခြားနားမှုရှိသည်။ သို့သော် ရေအောက်အတွင်းပေါက်ပြီး အပွင့်မှာရေပေါ်တွင် ပွင့်လေ့ရှိသော (elodeids) အမျိုးအစားများဖြစ်သည့် *Nechamandra alternifolia*၊ *Potamogeton lucen* နှင့် အဟာဓါတ်များသော နေရာများတွင် ပေါက်ပွားတက်သော ဗေဒါ *(Eichoria crassipes)* တို့ကို ရာသီမရွေး ပေါက်ရောက်မှု အများဆုံး ဖြစ်ကြောင်း တွေ့ရှိရပါသည်။

ရေပေါင်းပင်များ၏ ဂေဟစနစ်အခြေအနေကို သုံးသပ်အကဲဖြတ်ရာတွင် Norwegian trophic index (Tic), Relative abundance index (RA-index) နှင့် Submerged macrophyte coverage index (SMC index) စသည့် အညွှန်းကိန်း သုံးမျိုးကို အသုံးပြုထားပါသည်။ အညွှန်းကိန်းအမျိုးမျိုးပေါ်တွင် မူတည်၍ အင်းလေးကန်၏ ဂေဟစနစ်အခြေအနေမှာ သိသိသာသာ ကွဲပြားနိုင်ပါသည်။ ရေ၏ကြည်လင်မှုအားထိန်းသိမ်းရန် အထူးသဖြင့် အင်းလေးကန်ကဲ့သို့ ရေတိမ်ရေကန်များ အတွက် ရေပေါင်းပင် ပေါက်ရောက်မှုသည် အလွန် အရေးကြီးပါသည်။ ကန်အတွင်း အာဟာရဓါတ် ပို့ချမှု မြင့်မားသောကြောင့် ရေပေါင်းပင်ပေါက်ရောက်မှု လျော့နည်းလျှင် ရေညှိအမျိုးအစားများ၏ ဇီဝဒြပ်ထုပမာဏ ပိုမို တိုးပွားလာပြီး ရေ၏ကြည်လင်မှု လျော့နည်းလာနိုင်ပါသည်။ ယခုအခြေအနေအရ Relative abundance index (RA-index) နှင့်အတူ submerged cover index (RA-index) ကိုအသုံးပြုရန် အကြံပြုပါသည်။ သို့သော် မြန်မာနိုင်ငံအတွင်းရှိ ကန်များအားလုံးအတွက် သင့်တော်သော အညွှန်းကိန်းအမျိုးမျိုးကို ဆက်လက် သုံးသပ်သင့်ပါသည်။ အင်းလေးကန် အတွင်းရှိ ရေပေါင်းပင်များ၏ အခြေအနေမှာ Norwegian trophic index နှင့် ဘောင်သတ်မှတ်ချက်များ အရ ရေပေါင်းပင်မျိုးစိတ်များ၏ အာဟာရဓါတ်ပေါများမှုအပေါ် ထိခိုက်ခံနိုင်မှု အခြေအနေ ညံ့ဖျင်းကြောင်း တွေ့ရှိ ရပြီး ၂၀၁၄ နိုဝင်ဘာမှ ၂၀၁၅ နိုဝင်ဘာအတွင်း ပိုမိုဆိုးရွားလာပြီး ယနေ့အချိန်အထိ တူညီသောအနေအထားတွင် ရှိကြောင်း တွေ့ရှိရပါသည်။

အင်းလေးကန်၏ ဂေဟစနစ်အခြေအနေကို သုံးသပ်အကဲဖြတ်ရန် ရေညှိပင်များ၏ စိမ်းရောင်ချယ် (Chlorophyll) စမ်းသပ်မှုအပါအဝင် ရေညှိနှင့် ရေပေါင်းပင်များကို လေ့လာစောင့်ကြည့်ခြင်း အစီအစဉ်တစ်ရပ်ကို အကြံပြုပါသည်။ ထို့အပြင် အောက်စီဂျင်ပါဝင်မှု၊ ရေ၏ချဥ်ငန်ဓါတ်၊ ဆားဓါတ်ပါဝင်မှု၊ ကယ်လ်ဆီယမ်ဓါတ်၊ အော်ဂန်းနစ်ပစ္စည်းများပါဝင်မှုကို အခြေခံသည့် အရောင်၊ ရေနောက်ကျိမှု၊ စုစုပေါင်း ဖော့စဖောရပ်စ်ဓါတ်၊

ဖော့စဖိတ်ဓါတ်၊ စုစုပေါင်းနိုက်ထရိုဂျင်ဓါတ်၊ နိုက်ထရိုတ်ဓါတ်၊ အမိုးနီးယားဓါတ် နှင့် စုစုပေါင်းအောဂန်းနစ်ကာဗွန် အစရှိသည့် ရူပ–ဓါတု ဂုဏ်သတ္တိများကိုပါ ထည့်သွင်း လေ့လာသင့်ပါသည်။ ရေ၏ဓါတုအခြေအနေနှင့် ရေညှိပေါက်ပွားမှုအခြေအနေကို ၂၀၁၄ ခုနစ်မှ ၂၀၁၇ ခုနစ်အတွင်း ရေနမူနာကောက်ယူသည့် နေရာ ၁၄ နေရာ အနက် နေရာ ၆ နေရာ တွင် သာဆက်လက်လေ့လာနိုင်ပြီး ရေပေါင်းပင်စာရင်းကောက်ယူခြင်းကိုမူ နမူနာ ကောက်ယူသည့် နေရာ အားလုံးတွင် ဆက်လက်ကောက်ယူသင့်ပါသည်။

ကျွန်းမျှောများအတွင်းအသုံးပြုလျက်ရှိသည့် ပိုးသတ်ဆေးများ၏ အကျိုးသက်ရောက်မှုကို လေ့လာရန် ပိုးသတ်ဆေးအသုံးပြုသည့်ကာလအတွင်း လစဉ် ကျွန်းမျှောများမှ နူန်းနမူနာ ကောက်ယူသင့်ကြောင်း အကြံပြုပါသည်။ အသေးစား စက်မှုလုပ်ငန်းများမှ သတ္တုဓါတ်များ၏ ဆိုးကျိုးသက်ရောက်မှုကိုသိရှိရန် ရေထွက်ချောင်းနှင့် နီးသောနေရာနှင့် စက်ရုံများ၏အောက်ဖက်ပိုင်းနေရာများတွင် ရေနမူနာ ကောက်ယူသင့်ပါသည်။ လူနေ အိမ်ခြေများမှ ထွက်ရှိလာသော အညစ်အကြေးများသည် အာဟာရဓါတ်နှင့် ဘတ်တီးရီးယားပါဝင်မှုကို ညွှန်းဆိုသည့်အတွက် ဘတ်တီးရီးယားပေါက်ပွားမှု အခြေအနေကို ဘတ်တီးယားပေါက်ပွားမှု အမြင့်ဆုံးဖြစ်သည့် ခြောက်သွေ့သော ရာသီဥတုနှင့် နွေရာသီများတွင် စဉ်ဆက်မပြတ် လေ့လာသင့်ပါသည်။

အစီရင်ခံစာ ရေးသားပြုစုသူများ – Andreas Ballot၊ Marit Mjelde နှင့် သီတာဆွေ
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1. Introduction

Inlay Lake is the second largest natural lake in Myanmar and is of particular importance to the Myanmar people due to its cultural significance and beauty. However, the lake is affected by increasing population and rapid growth in both agriculture and tourism. Considering this situation, Inlay Lake was selected as a case study area in the project *Integrated Water Resources management, Institutional Building and Training*, to provide monitoring results for assessing the ecological status of the lake and to contribute to a lake monitoring programme.

As a first approach to ecological status assessments in Myanmar lakes, Mjelde et al. (2017) recommended some biological elements and indices and physico-chemical parameters based on the EU WFD (European Water Framework Directive). The EU WFD uses an ecosystem-based approach for characterising and classifying water quality using ecological water quality criteria, an approach designed to protect, preserve and improve the aquatic environment. The directive requires monitoring of the biological, physico-chemical and the hydro-morphological water quality elements. According to this directive, all surface water bodies should be classified into one of five normative classes; i.e. high, good, moderate, bad or poor ecological status. Inspired by the EU Water Framework Directive, the The National Water Resources Committee in Myanmar adopted in 2014 the National Water Framework Directive (NWFD). The NWFD which is a policy framework, presents seven principles for achieving good ecological status for the water quality elements in Myanmar water bodies and river basins, principles which reflects the EU WFD. Among these principles, number three is particularly relevant regarding the topic of this report:

NWFD, Principle (3): The ecological and chemical status of surface waters should be assessed according to the following criteria:

- Biological quality (fish, benthic invertebrates, aquatic flora)
- Hydro-morphological quality such as status of river banks, river bank structures, river training works, river continuity or substrate of the river bed
- Physical-chemical quality such as temperature, oxygenation and nutrient conditions
- Chemical quality that refers to environmental quality standards for river basin specific pollutants. These standards specify maximum concentrations for specific water pollutants. If even one such concentration is exceeded, the water body will not be classed as having a 'good ecological status'.

The main purpose of this report is to provide improved knowledge about aquatic biodiversity and water chemistry in Inlay Lake, and provide a preliminary assessment of the ecological status. In addition, its purpose is to develop preliminary recommendations for a monitoring programme for Inlay Lake, based on the suggested biological and chemical elements in Mjelde et al. (2017) and the improved dataset achieved here.

The preliminary ecological assessment has been discussed with authorities and experts from Myanmar in a workshop in Taunggyi 14th November 2017. A final classification of Inlay Lake, however, must be based on indices and boundaries developed exclusively for Myanmar, using a larger dataset from Myanmar water bodies. This preliminary monitoring program will be the baseline for further discussions with other experts, in Myanmar and elsewhere, for the development of a sampling and analysis protocol suitable for Inlay Lake and also for other lakes in Myanmar.

Chapter 2 gives a brief introduction to Inlay Lake and its catchment area, while Chapter 3 provides an overview of the field and analysis methods used in the period 2014-2017. Chapter 4 includes a succinct characterisation of the lake, water chemistry results and species diversity and abundance of phytoplankton and aquatic macrophytes, including assessment of ecological status based on Norwegian indices and boundaries. Chapter 5 provides a preliminary total assessment of physico-chemical status and ecological status for Inlay Lake, while a preliminary monitoring programme for the lake is suggested in chapter 6.

This report is one of the deliverables of the project *Integrated Water Resources management, Institutional Building and Training* (IWRM project), a collaboration between the Ministry of Natural Resources and Environmental Conservation (MONREC, previously MOECAF) and the Norwegian Institute for Water Research (NIVA) under the Norwegian - Myanmar Bilateral Environment Programme 2015-2018. The project aims to make a significant contribution to the implementation of well-functioning Integrated Water Resources Management (IWRM) for inland waters at the national level for Myanmar. Overall presentation of the EU WFD and other IWRM frameworks along with recommendations for IWRM in Myanmar are provided in in the report by Nesheim and Platjouw (2016): "Framework notes and recommendations for Integrated Water Resource management in Myanmar". Mjelde et al. (2017) presented an overview of water usage in Myanmar and preliminary suggestions for typology criteria and indices for assessing ecological status in lakes in Myanmar based on the EU WFD.

2. Inlay Lake

2.1 General information

Inlay Lake is situated in Nyaung Shwe township, Taunggyi District, Southern Shan State, in the eastern part of Myanmar (Figure 2.1), and is the second largest natural lake in Myanmar. It is located 884 meters above sea level in the Balu Chaung Valley between the Sinduang (east) and Letmaunggwe, Thandaung and Udaung mountain ranges (west). Today, the length of the lake is about 18 km and the width is 6 km. The lake surface is 116 km^2, however, varying between 150 km^2 in the rainy season and 100 km^2 in the dry season. It is a shallow lake, where maximum depth varies between approximately 4 m in the dry season and 5-6 m in the rainy season (IID 2012). The average depth is around 1.5 m in the dry season. In 2014-2017 a maximum depth of 3.7 m was measured (Table 2.1). The volume of Inlay Lake is 790 x 106 m^3. With a total water inflow of 1132 x 10^6 m^3 per year, the residence time can be estimated to 0.3 years (IID 2012).

Table 2.1. Characteristic data about Inlay Lake.

Water body	State	type	latitude	longitude	altitude m.a.sl.	lake area km^2	max. depth, m	mean depth, m
Inlay	Shan	natural lake	20,5725	96,911389	884	116	3.7	1.52

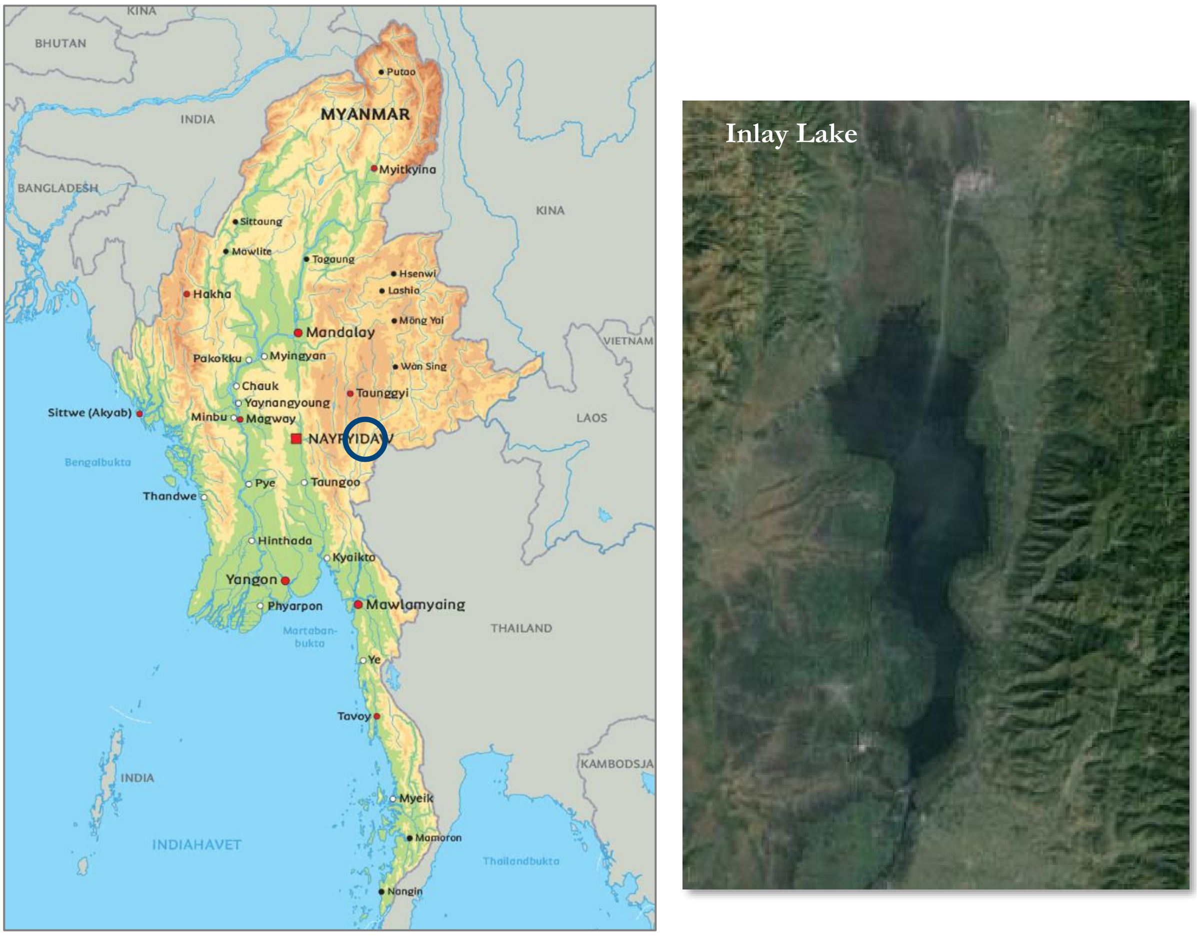

Figure 2.1. Inlay Lake in Myanmar. (Source: overview-map, www.albatros-travel.no; the satellite image is from Google Earth.)

The general formation of the lake is Shan Plateau limestone (Akaishi 2006), with limestone, dolomite and sandstone as the main bedrock components (http://www.mappery.com/Myanmar-Burma-Rock-Types-Map). As a result of the dominant limestone in the watershed, Inlay Lake is naturally alkaline, with high calcium concentration and pH values generally >8. In addition, the bedrock in the Inlay valley is covered by several meters of soil. The soil is mountainous brown and yellow brown, classified as Cambisol and Ferrasols according to FAO classification (MOECAF 2014).

2.2 Climate conditions

Most of Myanmar, including Shan state, has a tropical climate (Figure 2.2). The seasons at Inlay Lake are characterised by cold dry winter in November - February, hot dry summer season in March - May, and rainy season in June - October. The average annual temperature is about 23°C, while maximum temperature can reach more than 35°C during the summer season (Htwe 2015).

The average annual rainfall is about 950 mm, and the precipitation is mostly confined to the rainy season (May to October) (Akaishi 2006, referring to Ma 1996).

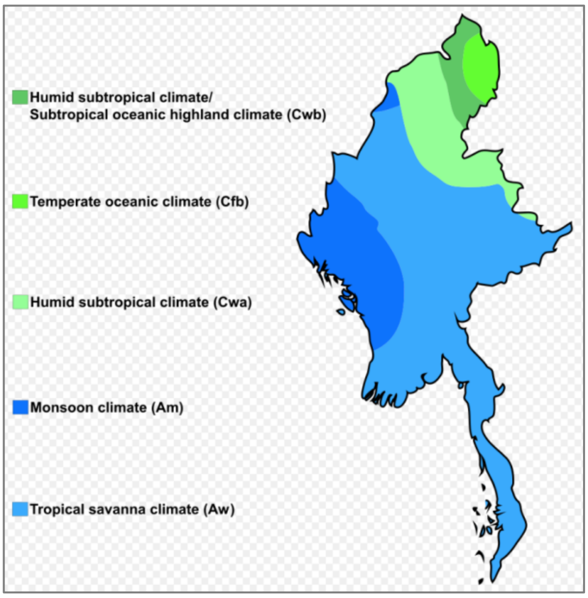

Figure 2.2. Main climate zones in Myanmar.
https://en.wikipedia.org/wiki/Geography_of_Myanmar

In summer the prevailing winds are south-westerly warm tropical winds, originating from the Bay of Bengal. In the cold season (December - February), the winds are north-easterly cold winds, originating from Central Asia (MOECAF 2014).

2.3 Main impacts

The deforestation in the Inlay Lake watershed is large. While open and closed forest cover 16% and 7%, respectively, degraded forest covers 30% of the watershed (MOECAF 2014). Deforestation is expected to be the main reason for the increasing silt load in Inlay Lake. The Forest Department of Myanmar has initiated an action plan for Inle Lake conservation, including natural forest protection, establishing forest plantation, etc. (MOECAF 2014, 2015).

The main business in Inlay Lake is agriculture on floating gardens. Tomato production from the lake farmers is over 300 tonnes/day in the tomato growing seasons, with annual production about 90,000 tonnes (for two growing seasons) (IID 2012). The floating islands have been cultivated for approximately 15 years, dependent on the floatability of the submerged mattress of vegetation and farmers' practices (Htwe 2015, referring to Than 2007). The farmers use chemical fertilisers, pesticides, and organic fertilisers for the tomato gardens.

Other businesses include fisheries, textile industries, weaving, and gold and silver-smithing (Akaishi 2006, referring to Ba 2003). FAO (2004) has estimated the annual production of fisheries in Nyaungshwe township to 550–650 tons. The lake is also important for transporting products around it and into distant townships.

There are 35 village tracts (group of rural villages) within Nyaung Shwe Township. Of these, 17 lie within the lake and 5 lie partly in the lake and partly on land. The remainder 13 village tracts are situated in the lake surroundings (MOECAF 2014). The most recent statistics indicate that the population concentration is 89 people/km^2 around the lake and 386 people/km^2 on the water (Htwe 2015). Many toilets in the area are ground pit latrines, which have bored holes in the back; some have a hole above the lake surface through which excretions are dropped directly into the lake. Even some factories and accommodation establishments that have septic tank systems do not adequately treat the sewage. UNDP suggested that 72% of households in Nyaungshwe township in 1999 used unsanitary open pits or had no latrines (FAO 2004). No wastewater treatment is done, and domestic drainage flows directly into the lake from around the area (Akaishi 2006).

Inlay Lake is one of three key tourism destinations in Myanmar, and attracts more than 300 000 visitors annually (IID 2012). Construction of hotels and the number of tourists are increasing considerably in the Inlay Lake area.

2.4 Inlet rivers

Inlay Lake has 4 main inlet rivers; Nan Latt, Upper Belu, Ka Law and Ye Pae, and the outlet river Belu Stream (Figure 2.3).

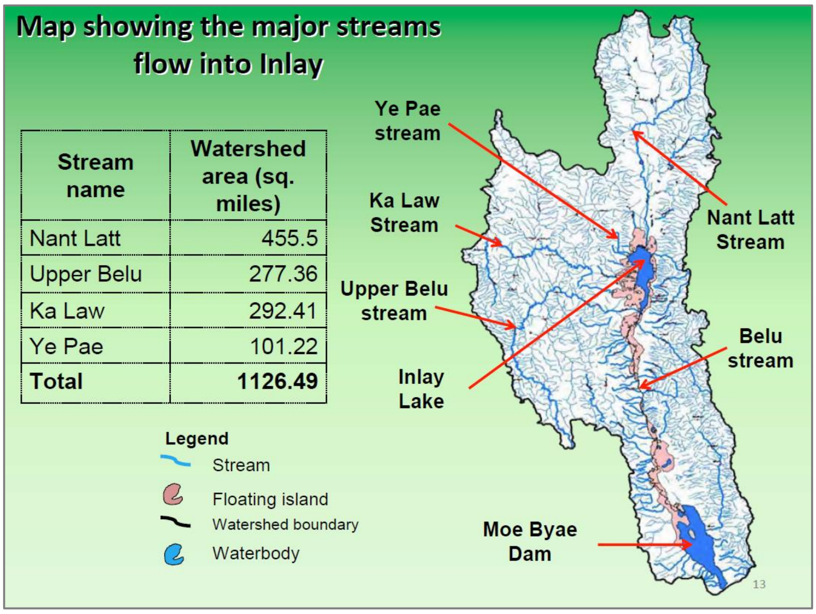

Figure 2.3. Inlay Lake and main inlet rivers. (Figure from MOECAF 2014).

Large volumes of silt as well as water are transported to the lake through the rivers (Table 2.2). Based on the numbers in the table, the total silt inflow from all sub-catchments can be estimated to ca. 270,000 tons per year (around 200g silt per m^3 water), whereas 62% deposited in deltas, 20% deposited in marshes and 1% deposited in the lake (Furuichi 2008).

Table 2.2 Inflow and silt load through the main inlet rivers. Data summarised by IID (2012). These values are slightly different from data from Shan State Irrigation Department (MOECAF 2014)

River	Watershed area km^2	Water inflow 10^6 m^3/yr	Silt flow t/yr	Run-off m^3/yr/km^2	Silt load t/yr/km^2
Nam Let (Nant Latt) Chaung	1149	505.5	104 000	439 948	91
Negya (Ye Pae) Chaung	250	92.5	19 000	370 000	76
Kalaw (Ka Law) Chaung	742	275.6	56 000	371 430	75
Indein (Nam Bilu) (Upper Belu?) Chaung	813	479.6	98 293	589 914	121
Balu Chaung (outlet river)	3640	332*			

*: outflow

3. Material and methods

3.1 Localities in Inlay Lake

Inlay Lake is dominated by intensive growth of aquatic macrophytes and the program for physico-chemical and biological sampling has been adapted accordingly.

As a first comprehensive sampling program for physico-chemical and biological parameters, we selected three transects with 4-5 sampling points each, in different parts of the lake (Figure 3.1 and Table 3.1). All 14 sampling points were investigated in November 2014, February and November 2015 and March2017, for water chemistry, phytoplankton and aquatic macrophytes. In addition, three more points were sampled for aquatic macrophytes (D, E1 and E2, see Table 3.1). At a reduced number of six sampling points (see Figure 3.1), phytoplankton and physico-chemical parameters were sampled monthly from March 2015 until October 2015.

Additionally, water samples for physio-chemical parameters were sampled in the inflowing river Belui (Belu) in November 2014 and February and November 2015. In November 2015, water samples were taken from two additional inflowing rivers, Nei Gyar (Ye Pae) and Tham Daung (Nant Latt), and from the outlet river. Additional data from these rivers are reported by Phoo, Thwin & Chan (in prep).

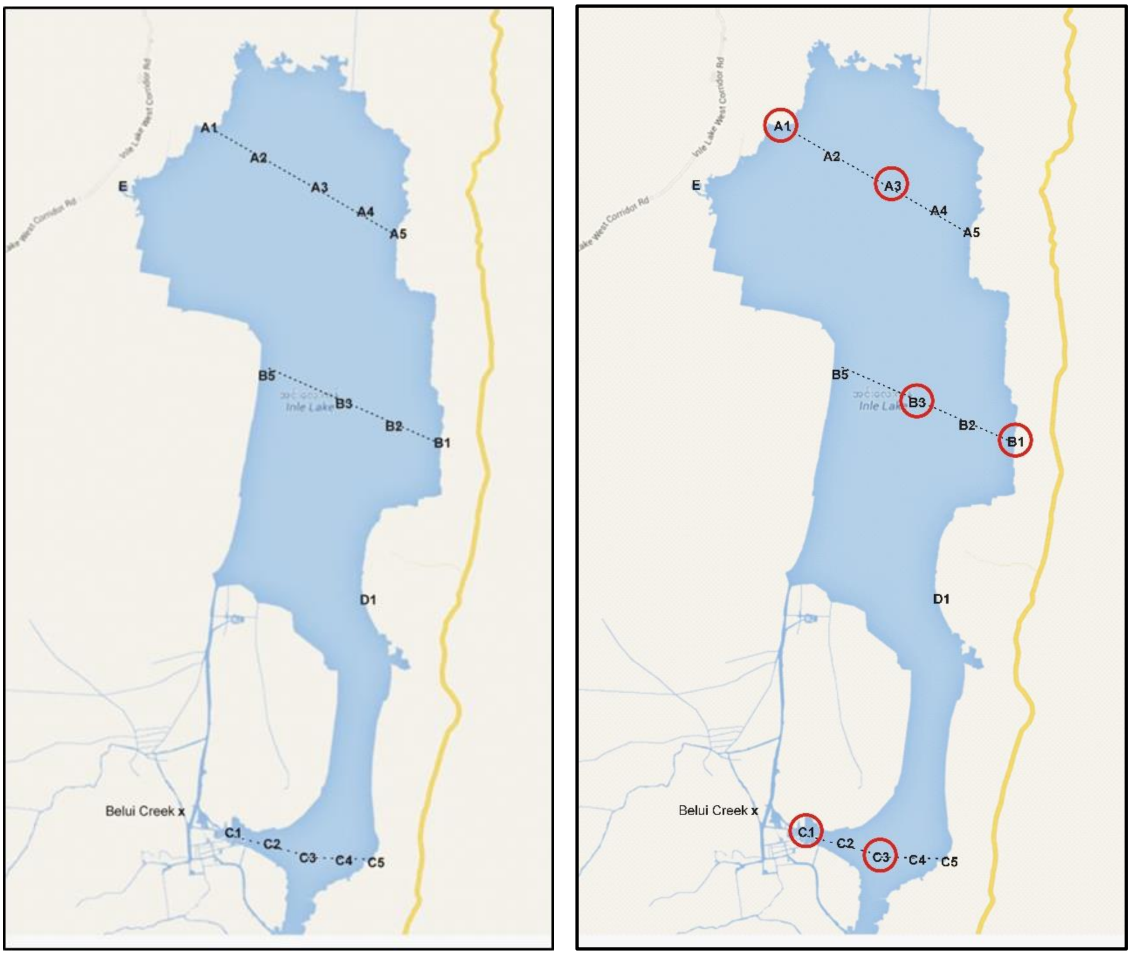

Figure 3.1. Sampling points for comprehensive sampling (left) and reduced set of sampling points for further sampling, red circles (right).

Table 3.1. Sampling points in Inlay Lake; November 2014, February and November 2015 and March 2017. W=water chemistry, PP=phytoplankton, AM=aquatic macrophytes.

Loc. no	Latitude	Longitude	Quality elements	Additional sampling
A1	20,603837	96,8956	W, PP, AM	monthly from Nov 2014 – Nov. 2015
A2	20,602125	96,901859	W, PP, AM	
A3	20,593999	96,91322	W, PP, AM	monthly from Nov 2014 – Nov. 2015
A4	20,589542	96,919611	W, PP, AM	
A5	20,58426	96,927998	W, PP, AM	
B1	20,550628	96,935768	W, PP, AM	monthly from Nov 2014 – Nov. 2015
B2	20,553565	96,926082	W, PP, AM	
B3	20,557946	96,918544	W, PP, AM	monthly from Nov 2014 – Nov. 2015
B5	20,562589	96,902898	W, PP, AM	
C1	20,48066	96,895886	W, PP, AM	monthly from Nov 2014 – Nov. 2015
C2	20,477061	96,901475	W, PP, AM	
C3	20,473896	96,910144	W, PP, AM	monthly from Nov 2014 – Nov. 2015
C4	20,470792	96,913435	W, PP, AM	
C5	20,47489	96,923759	W, PP, AM	
D1	20,519588	96,923003	W, PP, AM	
E1	20,591895	96,878807	AM	
E2	20,592841	96,876751	AM	

3.2 Field and analysis methods

All sample and analysis methods are in accordance with suggested methods in Mjelde et al. (2017), and based on the EU Water Framework Directive (WFD). The main focus in the EU WFD is the status of the biological elements, while the physico-chemical elements are supporting quality elements and assigned to detect the main pressures for rivers and lakes. The main focus of this report is eutrophication pressure, however, some input on priority substances are given.

3.2.1 Physical measurements and water chemistry

Physical measurements and water samples were taken at approximately 20 cm water depth at selected localities in the lake (Figure 3.1. and Table 3.1). The water samples were preserved in the field with 4M H_2SO_4 or not preserved and transported to NIVA. The analyses included calcium, colour, NH_4, NO_3, PO_4, total nitrogen (NT) and total phosphorus (TP). Calcium and colour are used in the characterization of the lake, while the nutrients are supporting quality elements to assess eutrophication pressure. Secchi depth, which is one of the main measurements, is not included due to the shallowness of the lake.
All chemical analyses are analysed according to standard methods (Direktoratsgruppa 2009), conducted at NIVA's chemical laboratory in Norway, while the physical measurements are done using field instruments.

In this phase, we present boundaries for the selected physico-chemical parameters in Norwegian lake types (Direktoratsgruppa 2015), see Table 3.2-3.5. The boundaries are used with data from Inlay Lake and from the inlet and outlet rivers as a classification example, to assess a physico-chemical status. The use of the Norwegian boundaries is a first approach. The boundaries need to be evaluated based on additional data from Myanmar lakes, feedback from experts from Myanmar, and compared to other assessment systems in Europe and Asia.

Table 3.2. Boundaries for total phosphorous (TP) in different lake types in **Norway** (from Direktoratsgruppa 2015).

Altitude	Type	high	good	moderate	poor	bad
Lowland	siliceous, clear, shallow	1-7	7-11	11-20	20-40	>40
Lowland	siliceous, clear, deep	1-4	4-9	9-16	16-38	>38
Lowland	siliceous, humus-rich	1-11	11-16	16-30	30-55	>55
Lowland	calcareous, clear	1-10	10-17	17-26	26-42	>42
Lowland	calcareous, humus-rich	1-13	13-20	20-39	39-65	>65
Forest	siliceous, clear	1-5	5-10	10-17	17-36	>36
Forest	siliceous, humus-rich	1-9	9-13	13-24	24-45	>45
Forest	calcareous clear	1-7	7-11	11-20	20-40	>83
Mountains	siliceous, clear	1-3	3-5	5-11	11-20	>40
Mountains	siliceous, humus-rich	1-5	5-10	10-17	17-36	>36

Table 3.3. Boundaries for total nitrogen (TN) in different lake and river types in **Norway** (from Direktoratsgruppa 2015).

Altitude	Type	high	good	moderate	poor	bad
Lowland	siliceous, clear, shallow	1-325	325-475	475-775	775-1350	>1350
Lowland	siliceous, clear, deep	1-200	200-400	400-650	650-1300	>1300
Lowland	siliceous, humus-rich	1-475	475-650	650-1075	1075-1755	>1755
Lowland	calcareous, clear	1-425	425-675	675-950	950-1425	>1425
Lowland	calcareous, humus-rich	1-550	550-775	775-1325	1325-2025	>2025
Forest	siliceous, clear	1-250	250-425	425-675	675-1250	>1250
Forest	siliceous humus-rich	1-400	400-550	550-900	900-1500	>1500
Forest	calcareous humus -rich	1-475	475-650	650-1075	1075-1755	>1755
Mountains	siliceous, clear	1-175	175-250	250-475	475-775	>775
Mountains	siliceous humus-rich	1-250	250-425	425-675	675-1250	>1250

Table 3.4. Boundaries for total phosphorous (TP) in different rivers types in **Norway** (from Direktoratsgruppa 2015).

Altitude	Type	high	good	moderate	poor	bad
Lowland	siliceous, clear, shallow	1-11	11-17	17-30	30-60	>60
Lowland	siliceous, humus-rich	1-17	17-24	24-45	45-83	>83
Lowland	calcareous, clear	1-15	15-25	25-38	38-65	>65
Lowland	calcareous, humus-rich	1-20	20-29	29-58	58-98	>98
Forest	siliceous, clear	1-8	8-15	15-25	25-55	>55
Forest	siliceous, humus-rich	1-14	14-20	20-36	36-68	>68
Forest	calcareous humus -rich	1-17	17-24	24-45	45-83	>83
Mountains	siliceous, clear	1-5	5-8	8-17	17-30	>30
Mountains	siliceous humus-rich	1-8	8-15	15-25	25-55	>55

Table 3.5. Boundaries for ammonium (NH_4+NH_3) and free ammonia (NH_3) in lakes and rivers in **Norway** (from Direktoratsgruppa 2015).

Watertype	Parameter	high	good	moderate	poor	bad
All types	free ammoniac (NH_3)	1-5	5-10	10-15	15-25	>25
All types	Total ammonium (NH_3+NH_4)	10-30	30-60	60-100	100-160	>160

* only valid for pH > 8 and temp. > 25 ^{0}C.

3.2.2 Phytoplankton

Field method

Qualitative samples using a plankton net (pore size 20 µm) and quantitative water samples using a Limnos water sampler for phytoplankton composition and biomass were taken in Inlay Lake (Figure 3.1. and Table 3.1). All samples were fixed with Formaldehyde (for qualitative analysis) or acidic Lugol's solution (for quantitative analysis), stored in the dark and later analysed at NIVA. For the analysis of the qualitive samples compound microscopy was used and for the analysis of the quantitative samples, plankton sedimentation and counting chambers according to Utermoehl (1958) and inverted microscopy was used. Samples for chlorophyll- a were not taken, since all samples, at this stage, had to be transported and analysed at the laboratory at the Norwegian Institute for Water Research.

Analysis methods

The species are identified to species or genus level, using selected identification keys (Büdel et al. 1978-2015, Croasdale 1983, Huber-Pestalozzi 1969, Komárek et al. 1983, Prescott et al 1977, 1981, 1982, Skuja 1949). Several taxa, however, can only be determined to genus or family level so far. Additionally, genetic methods are used for the identification of some uncertain taxa.

Testing trophic indices

Several parameters are used to characterise the ecological status of lakes with phytoplankton: chlorophyll a, total biovolume of phytoplankton, Phytoplankton Trophic Index (PTI) and biomass of cyanobacteria The four indices which are developed for phytoplankton combine all the changes and are well correlated to total phosphorous in lakes (Lyche-Solheim et al 2013). Chlorophyll- a is the most important pigment involved in the photosynthesis of phytoplankton and can be used as a proxy for phytoplankton biomass.

The Phytoplankton Trophic Index (PTI) describes the increase of tolerant species (often nuisance algae or cyanobacteria) and the reduction of sensitive taxa along the phosphorus gradient. The index is based on a modification of Ptacnik et al. (2009) (Direktoratsgruppen 2015). It sums up the indicator value for each taxon in a sample in relation to the proportion of each taxon in the sample. The indicator value for each taxon can vary from 1 to 5. The index value for lakes can vary between 1.5 and 4.0. The maximum volume for cyanobacteria (Cyanomax) describes the biomass of cyanobacteria.

$$PTI = \frac{\sum_{j=1}^{n} a_j s_j}{\sum_{j=1}^{n} a_j}$$

aj = proportion of taxon j in a sample
sj= indicator value for taxon j in a sample

Cyanobacteria are associated with eutrophication in lakes. They can produce high biomasses and are potential toxin producers. Their presence can limit the use of lakes as drinking water source for recreation and other purposes. This index reflects an unwanted disturbance of the phytoplankton community and is linked to risk levels of the WHO (1999).

WHO defines different risk levels. The thresholds are 4 000, 20 000 and 100 000 cells/ml (WHO 1999). These values are converted to biovolume thresholds of 0.2, 1 and 5 mm^3/l (or mg/l) and multiplied with a cell volume (based on spherical cells like those from *Microcystis* (cyanobacteria) with a cell diameter of 4.5 µm (Hillebrand et al. 1999).

In this report, we are testing the combination of the indices PTI, Cyanomax and phytoplankton biovolum see suggestions in Mjelde et al. (2017). Because of the methodological challenges, chlorophyll was not included in the sampling procedure in Inlay Lake as part of this project.

We present boundaries for the phytoplankton indices in Norwegian lake types (Direktoratsgruppa 2015), see Table 3.6. The boundaries are used for data from Inlay Lake as a classification example, to assess biological status. The use of the Norwegian boundaries is a first approach. The boundaries need to be evaluated based on additional data from Myanmar lakes, feedback from experts from Myanmar, and compared to other assessment systems in Europe and Asia.

Table 3.6. Class boundaries for phytoplankton-indices in **Norwegian lakes**. H=high, G=good, M=moderate, P=poor, B=bad.

Lake-Type	Class	chlorophyll µg/l	Biovolume mg/l	PTI	Cyanomax mg/l
Lowland, calcareous, clear, shallow	H	<6	<0.64	<2.26	<0.16
	G	6-9	0.64-1.04	2.26-2.43	1.00
	M	9-18	1.04-2.35	2.43-2.60	1.00-2.00
	P	18-36	2.35-5.33	2.60-2.86	2.00-5.00
	B	>36	>5.33	2.86-4.0	>5.00
Lowland, siliceous, clear, shallow or Forest, calcareous, clear, shallow	H	<4	<0.40	<2.17	<0.16
	G	4-6	0.40-0.64	2.17-2.34	0.16-1.00
	M	6-13	0.64-1.60	2.34-2.51	1.00-2.00
	P	13-27	1.60-3.79	2.51-2.69	2.00-5.00
	B	>27	>3.79	2.69-4.0	>5.00
Lowland, siliceous, clear, deep	H	<2	<0.18	<2.09	<0.16
	G	2-4	0.18-0.40	2.09-2.26	0.16-1.00
	M	4-7	0.40-0.77	2.26-2.43	1.00-2.00
	P	7-15	0.77-1.90	2.43-2.60	2.00-5.00
	B	>15	>1.90	2.60-4.0	>5.00
Lowland, siliceous, humus-rich, shallow or Forest, calcareous, humus-rich, shallow	H	<5,4	<0.60	<2.26	<0.16
	G	5,4-9	0.60-1.00	2.26-2.43	0.16-1.00
	M	9-16	1.00-2.00	2.43-2.60	1.00-2.00
	P	16-32	2.00-4.60	2.60-2.86	2.00-5.00
	B	>32	>4.60	2.86-4.0	>5.00
Lowland, siliceous, clear, shallow or deep Forest, siliceous, clear, shallow or deep	H	<2	<0.18	<2.00	<0-0.16
	G	2-4	0.18-0.40	2.00-2.17	0.16-1.00
	M	4-7	0.40-0.77	2.17-2.34	1.00-2.00
	P	7-15	0.77-1.90	2.34-2.51	2.00-5.00
	B	>15	>1.90	2.51-4.0	>5.00
Lowland or forest, siliceous, humus-rich, shallow	H	<4	<0.40	<2.17	<0.16
	G	4-6	0.40-0.64	2.17-2.34	0.16-1.00
	M	6-12	0.64-1.46	2.34-2.51	1.00-2.00
	P	12-25	1.46-3.46	2.51-2.69	2.00-5.00
	B	>25	>3.46	2.69-4.0	>5.00
Lowland, calcareous, humus-rich, shallow	H	<7	<0.77	<2.39	<0.16
	G	7-10,5	0.77-1.24	2.39-2.56	0.16-1.00
	M	10,5-20	1.24-2.66	2.56-2.73	1.00-2.00
	P	20-40	2.66-6.03	2.73-3.07	2.00-5.00
	B	>40	>6.03	3.07-4.0	>5.00

3.2.3 Aquatic macrophytes

Definition

A simple definition of aquatic macrophytes is plants growing in or close to the water. They can be divided into semi-aquatic plants (i.e. emergent plants, helophytes) and aquatic macrophytes (hydrophytes), i.e. submerged plants or plants with floating leaves. In this study we only include aquatic macrophytes (hydrophytes), i.e. species in the lifeform groups *isoetids, elodeids, nymphaeids, lemnids*, and *charophytes* (Mjelde, in prep.).

Field method

The surveys of aquatic macrophytes in Inlay Lake took place in November 2014, and February and November 2015. The survey included the 14 main localities in the lake (see Figure 3.1 and Table 3.1), and two additional localities (E and D1, Figure 3.1), to ensure eventually species differences in this close to shore habitat. At each locality the plants were recorded using an aqua scope and collected by dredging from the boat (casting rake).

The abundances of the species are scored by a semi-quantitative scale, where 1 = rare, 2 = scattered, 3 = common, 4 = locally dominant and 5 = dominant. The lake is very shallow, and the aquatic macrophytes are covering the whole depth gradient.

Analysis method

All species are identified to species levels, using the floras and identification keys suggested below. Most of the identification was done in the field. However, a few specimens of each species are collected and dried. This herbarium collection is used for identification using microscope and for genetic analysis.

The dominant species in the lake are presented as abundance (sum semi-quantitative scores of all localities where the species occur) and % frequency (number of localities with occurrence compared to total visited localities).

Flora and identification keys

For species identification, we have used the keys in standard floras for the region, i.e. Cook (1996), in addition to updated or more specialised taxonomic work, e.g. Wiegleb (1990), Wiegleb & Kaplan (1998), Ito et al. (2014), Triest (1988), La-Ongsri (2008), in addition to different internet-sites like Flora of China (http//www.efloras.org) and Encyclopedia of Life (http//eol.org). The *Chara*-species are identified based on Wood & Imahori (1965).

In the Asian region, some aquatic macrophyte genera are very variable without satisfactory taxonomic treatment. In addition, several genera have been cultivated for a long time, e.g. among the *Nymphaea* species, which may confuse the taxonomic identification due to changes in their morphology. For these taxa, and other difficult genera, additional genetic analysis is needed as an identification supplement.

Testing different indices

Coverage and species richness of macrophytes decrease with increasing nutrient concentrations and phytoplankton biomass in the lakes (Phillips, et al., 1978, Rørslett, 1991). Shading by phytoplankton, epiphytic algae, or competition for nutrients leads to a change from the submerged isoetids or charophytes, via elodeids, to floating leaved or free-floating species, and in the end to phytoplankton dominance (see Mjelde and Faafeng, 1997, with references).

Mjelde et al. (2017) suggested three possible indices; In this report, we have tested two of the possible indices; the Norwegian trophic index (TIc-index) and a relative abundance index (RA index).
The TIc-index include the ratio between sensitive and tolerant species, the RA-index include ratio between sensitive and tolerant lifeform groups, while the SMC-index include a whole lake coverage.

Trophic index
The index is based on the relationship between species sensitive to eutrophication and species that are tolerant to this impact (Mjelde et al., in prep.).

$$TI_C = \frac{N_S - N_T}{N} \times 100$$

N_S is the number of sensitive species, while N_T is the number of tolerant species. N is the total number of all aquatic macrophyte species.

The index-value can vary between +100, if all present species are sensitive, and -100, if they are tolerant. The index calculates one value for each lake, however, for larger lakes index-values for different parts of the lake should be considered.

The different species of aquatic macrophytes have various distribution patterns, and most of the species found in temperate regions in Northern Europe are rare or non-existing in the tropical regions, and vice versa. Species sensitivity has to be established exclusively for Myanmar or for South-Eastern Asia. As a start, Mjelde et al. (2017) suggested a preliminary list of sensitive and tolerant species, based on expert judgement and literature survey both from temperate and tropical areas (see Table 3.7). The list is an important basis for calculating the trophic index and to give a correct ecological status assessment. This preliminary list has to be corrected and updated as soon as more data are available from Myanmar.

Boundaries for the TIc-index only exist for Norwegian lake types (Direktoratsgruppa 2015), see Table 3.8. The boundaries will be used with data from Inlay Lake as a classification example, to assess biological status. The use of the Norwegian boundaries is a first approach. The boundaries need to be evaluated based on additional data from Myanmar lakes, feedback from experts from Myanmar, and compared to other assessment systems in Europe and Asia.

Table 3.7. Suggested eutrophication sensitivity for aquatic macrophytes identified through our investigations in Myanmar lakes. The background for the sensitivity is explaned in Mjelde et al (2017). S=sensitive, T=tolerant, I=indifferent.

Latin names	Preliminary sensitivity
ELODEIDS	
Ceratophyllum demersum	T
Hydrilla verticillata	S
Limnophila sessiflora	I
Myriophyllum spicatum	T
Myriophyllum verticillatum	T
Najas indica	I
Najas minor	I
Nechamandra alternifolia	T
Potamogeton crispus	I
Potamogeton lucens	S
Potamogeton nodosus	I
Potamogeton pusillus	I
Potamogeton nodosus-hybrid?	-
Potamogeton sp.	-
Stuckenia pectinata	T
Utricularia aurea	S
Utricularia australis	S
Utricularia punctata	S
Utricularia stellaris	S
Utricularia sp	S
Vallisneria spiralis	I

Latin names	Preliminary sensitivity
NYMPHAEIDS	
Euryale ferox	S
Nelumbo nucifera	I
Nymphaea cyanea	I
Nymphaea nouchali	I
Nymphaea pubescens	I
Nymphaea rubra	I
Nymphoides indica	T
Nymphoides hydrophylla	T
Nymphoides cordata	T
Ottelia alismoides	I
Ottelia ovalifolia	I
Trapa natans v. bispinosa	T
Trapa natans v. natans	T
LEMNIDS	
Azolla pinnata	T
Eichornia crassipes	T
Lemna trisulca	I
Pistia stratiotes	T
Spirodela polyrhizza	I
Salvinia cucullate	T
Salvinia natans	T
CHAROPHYTES	
Chara sp. zeylandica	S

Table 3.8. Class boundaries for the aquatic macrophyte TIc-index in **Norwegian** lakes. H=high, G=good, M=moderate, P=poor, B=bad (from Direktoratsgruppa 2015).

Lake type		Calcium mg Ca/l	Colour mg Pt/l	reference value	H/G	G/M	M/P	P/B
001	Very low alkalinity, clear	<1	<30	95	92	55	40	15
002	Very low alkalinity, humic	<1	>30	78	71	55	40	15
101	Low alkalinity, clear	1-4	<30	79	75	55	40	15
102	Low alkalinity, humic	1-4	>30	78	71	55	40	15
201	Moderate alkalinity, clear	4-20	<30	74	66	30	5	-35
202	Moderate alkalinity, humic	4-20	>30	69	67	30	5	-35
301	High alkalinity, clear	>20	<30	75	63	30	5	-35
302	High alkalinity, humic	>20	>30	73	63	30	5	-35

Relative abundance index (RA index)

As recommended by Mjelde et al. (2017), we have tested metrics based on the relative abundance of the lifeform group charophytes (considered as sensitive to eutrophication) and the lemnids (tolerant to eutrophication). It is an overall agreement of the sensitivities of these lifeform groups (Penning et al 2008a, b), which make such an index more robust at this stage. Furthermore, we include the relative abundance of the sensitive elodeid *Potamogeton lucens* (Table 3.9). The average of the metrics in all localities in the lake gives a number 1-5, where 5 = high status, 4 = good status, 3 = moderate status, 2 = poor status and 1 = bad status. Decision of boundary borders are examples, and have to be tested further with available data from Myanmar lakes.

Table 3.9. Suggested abundance index, with possible metrics for assessing ecological status for aquatic macrophytes.

Indices and metrics	High (5)	Good (4)	Moderate (3)	Poor (2)	Bad (1)
RA: relative abundance index					
- *Potamogeton lucens* [1]	3	4-5	2	1	0
-charophytes [1]	4-5	3	2	1	0
-lemnids [1]	0	1-2	3	4	5

RA: relative abundance, 1: one or more species at each locality with given semi-quantitative score,
2: average semi-quantitative score

4. Results

4.1 Identification of water bodies and typology

Based on preliminary type factors suggested by Mjelde et al. (2017), and the morphological and water chemistry data (Table 2.1 and Table 4.2), Inlay Lake can be characterised as a **mid-altitude, very large and very shallow, calcareous, clear lake** (Table 4.1).

Table 4.1. Characteristic data for the lake.

Water body	State	Type	Altitude m.a.sl.	Lake Area km^2	Max. depth, m	Mean depth, m	Calcium mg Ca/l	TOC mg/l
Inlay	Shan	natural lake	884	116	3.7	1.52	48.8	4.8

4.2 Water chemistry

4.2.1 Variations

Inlay Lake is a shallow lake with inflow from 4 large rivers. The water is clear in the middle of the lake; (Table 4.2). However, some of the inflowing rivers have high turbidity (Table 4.3) which affect some parts of the lake. The lake is a calcareous lake, with an average calcium value of 49 mg Ca/l. With average colour values of 17 mg Pt/l it can be characterised as a clear lake. The nutrient concentrations in Inlay Lake show mesotrophic to semi-eutrophic conditions (Salas and Martino 1991), however, see discussion in next chapter. Both phosphorous and nitrogen concentrations are generally higher in the investigated inlet rivers (Table 4.3 and 4.4).

The inflowing rivers transport total suspended solids (TSS), which include inorganic and organic material, into the lake. The ranges measured in this study varied between 149 g/m^3 in Belui river and 48 g/m^3 in Nay Gyar. The loads are a little bit lower than the transport of 200 g silt/m^3 water described by IID (2012).

Table 4.2. Physico-chemical data from Inlay Lake 2014-2017 (min, max and mean values).

Period 2014-2017	Water temp. °C	pH	Conductivity µS/cm	Turbidity FNU	Silikate µg/l	TOC mg C/l
Min	20.30	7.33	286	0.64	1920	1.20
Max	28.00	9.43	491	0.64	13400	10.70
Mean	**24.71**	**8.26**	**367**	0.64	**6746**	**5.1**

Table 4.2. cont.

Period 2014-2017	Calcium mg Ca/l	Colour mg Pt/l	Tot-P/L µg P/l	PO4-P µg P/l	Tot-N/L µg N/l	NH4-N µg N/l	NO3-N+NO2-N µg N/l	Cl mg/l	SO4 mg/l
Min	26.2	16.7	3	1.0	128.0	21.0	3.0	6.4	2.9
Max	55.0	16.7	122	15.0	810.0	75.0	340.0	6.4	3.4
Mean	**42.2**	**16.7**	**16.3**	**3.8**	**472.9**	**38.7**	**38.6**	**6.4**	**3.2**

Table 4.3. Physico-chemical data from Belui (Belu) river 2014-2015 (min, max and mean values).

Period	Water temp., °C	pH	Conductivity µS/cm	Turbidity FNU	LOI mg/l	TSS mg/l	Silikate µg/l	TOC mg C/l
Min	21.70	8.19	352	39	129	149	7590	0.6
Max	25.20	8.36	483	39	129	149	11400	1.4
Mean	**23.6**	**8.28**	**407**	**39**	**129**	**149**	**9495**	**1.0**

TSS = total suspended solids, LOI = loss of ignition

Table 4.3. cont.

Period 2014-2015	Calcium mg Ca/l	Colour mg Pt/l	Tot-P/L µg P/l	PO4-P µg P/l	Tot-N/L µg N/l	NH4-N µg N/l	NO3-N+NO2-N µg N/l	Cl mg/l	SO4 mg/l
Min	51.5	3	18	13	635	19	485	2.0	2.8
Max	51.5	3	57	29	690	30	550	2.0	2.8
Mean	**51.5**	**3**	**38**	**21**	**663**	**25**	**518**	**2.0**	**2.8**

Table 4.4. Physical chemical data from the inlet rivers Tham Daung (Nant Latt) and Nei Gyar (Ye Pae), and the Inlay outlet river (23. November 2015).

River	Water temp., °C	pH	Conductivity µS/cm	Turbidity FNU	LOI mg/l	TSS mg/l	Silikate µg/l	TOC mg C/l
Tham Daung	24.0	8.19	483	-	54	61	9800	0.98
Nei Gyar	22.5	7.57	485	-	39	48	10600	4.7
Inlay outlet	24.1	7.61	367	-	-	-	11700	5

Table 4.4. cont.

River	Calcium mg Ca/l	Colour mg Pt/l	Tot-P/L µg P/l	PO4-P µg P/l	Tot-N/L µg N/l	NH4-N µg N/l	NO3-N+NO2-N µg N/l	Cl mg/l	SO4 mg/l
Tham Daung	-	-	27	14	620	14	500	-	-
Nei Gyar	-	-	42	20	560	60	130	-	-
Inlay outlet	-	-	23	8	475	40	20	-	-

4.2.2 Classification of physico-chemical parameters

The main focus in the EU WFD is the status of the biological elements. The physico-chemical elements are supporting quality elements and assigned to detect the main pressures for rivers and lakes.

An important impact on Inlay Lake is increased nutrient loading and eutrophication. We therefore focus on nutrient concentration, and the parameters ammonium (NH_4), total nitrogen (TN) and total phosphorous (TP) are used to exemplify the classification for the supporting physico-chemical elements. The parameter oxygen is not relevant in a shallow lake like Inlay Lake, due to frequent mixing of the water column. The secchi depth cannot be used because the secchi disc will always be visible to the bottom of the lake.

Total nitrogen

Inlay Lake had in most parts, low total nitrogen (TN) concentrations measured in 2014 and 2015 (Figure 4.1). The sampling points A3, B3 and C3 located in the lake centre had low or moderate concentrations. The other sampling points which are located close to the shore showed higher TN-concentrations. This reflects clearly the influence of fertilisers and wastewater from the floating garden and villages. It can be assumed that most of the nutrients are taken up by the aquatic macrophytes which densely cover most parts of the lake bottom. This suggests, that most of the nutrients are not available for the growth of phytoplankton.

All three inflowing rivers are sources of TN in Inlay Lake. The TN-concentrations are only slightly higher than those measured in Inlay Lake.

Ammonium

The parameter ammonium shows a similar picture (Figure 4.2). Only sampling point A4 had high ammonium concentrations, that could be classified as moderate according to Norwegian boundaries (Figure 4.2). Three of the rivers had low ammonium concentrations while the Nei Gyar River (Ye Pae) in the North of Inlay Lake, had higher ammonium concentration.

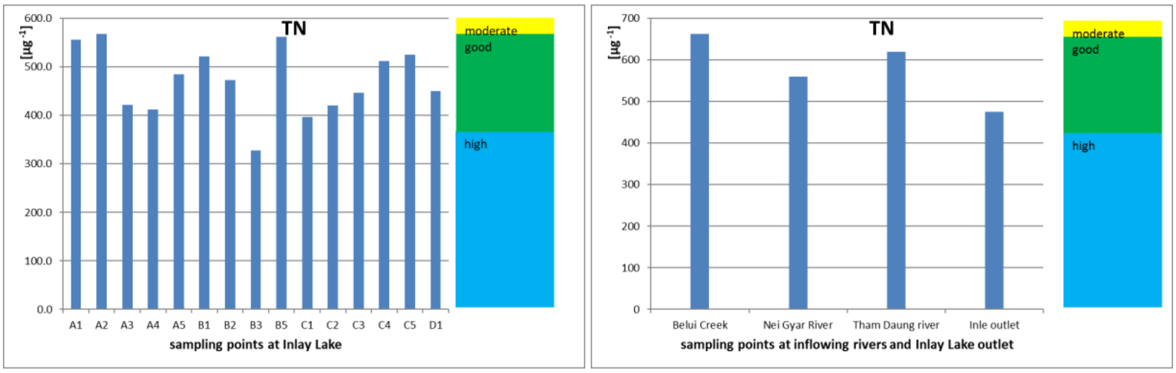

Figure 4.1. Total nitrogen (TN) concentrations in Inlay Lake (left), and tributaries Belui (Belu), Tham Daung (Nant Latt) and Nei Gyar (Ye Pae), and outlet river (right) (sampling points, see Figure 3.1). The graphs are based on average total nitrogen concentrations (Table 4.2-4.4), while the classifications are exemplified based on Norwegian boundaries in Table 3.3.

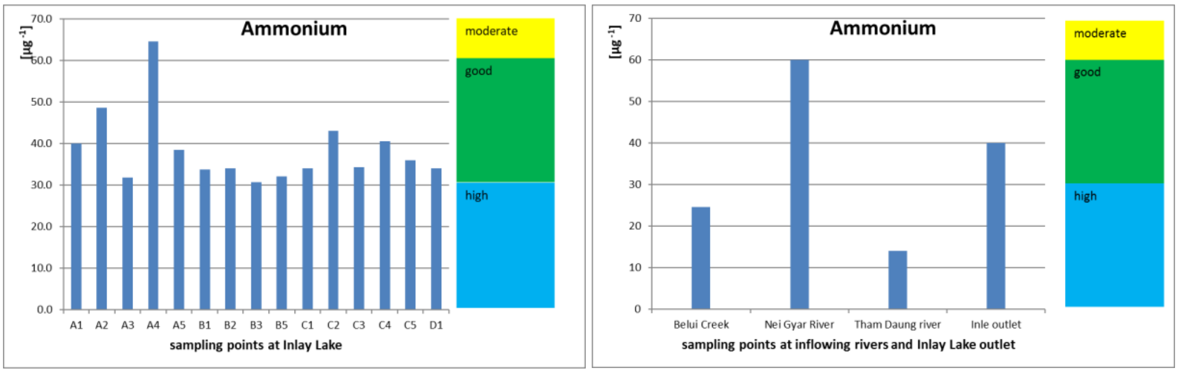

Figure 4.2. Ammonium concentration in Inlay Lake (left), and tributaries Belui (Belu), Tham Daung (Nant Latt) and Nei Gyar (Ye Pae), and outlet river (right) (sampling points, see Figure 3.1). The graphs are based on average ammonium concentrations (Table 4.2-4.4), while the classifications are exemplified based on Norwegian boundaries in Table 3.5.

Total phosphorus

Total phosphorous (TP) concentrations were low in most parts of Inlay Lake (Figure 4.3), and the sampling points A2-4 and B2-3 in the lake can be characterised by very good and good status according to Norwegian boundaries. All sampling points close to the shore and the sampling points in the C transect had high TP concentrations. The reasons for the high TP concentrations are the influence of the floating gardens and the domestic wastewater from the villages, especially in the southern part of the lake. It is also most likely that higher amounts of TP are stored in the sediments of Inlay Lake, and in the large stands of aquatic macrophytes that cover the lake bottom.

The inflowing rivers are transporting TP into the lake. All investigated rivers are characterised by high TP-concentrations characterising them to be in a moderate to bad status. The high TP values originate from erosion and use of fertilisers in the catchment area and wastewater from settlements.

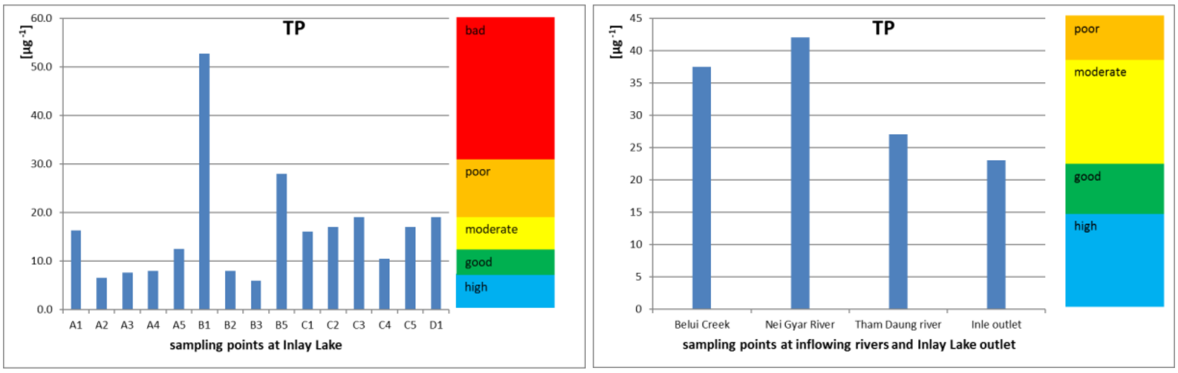

Figure 4.3. Total phosphorus (TP) concentrations in Inlay Lake (left), and in tributaries Belui (Belu), Tham Daung (Nant Latt) and Nei Gyar (Ye Pae), and outlet river (right) (sampling points, see Fig. 3.1). The graphs are based on average total phosphorus (TP)-concentrations (Table 4.2-4.4), while the classifications are exemplified based on Norwegian boundaries in Table 3.3 and 3.5.

4.3 Phytoplankton

4.3.1 Species diversity and abundance

The phytoplankton composition and biomass are influenced by the availability of nutrients, especially phosphorous and nitrogen compounds. The three transects including 14 sampling points A1-A5, B1-B5 and C1-C5, were analysed for phytoplankton composition and its abundance. During the four field sampling episodes in November 2014, February 2015 and November 2015 and March 2017 altogether 269 phytoplankton taxa were identified at the fourteen sampling locations. The phytoplankton taxa and their abundance based on a semi-quantitative scale are depicted in Appendix B. As several taxa could be determined to genus level only, the number of taxa present in Inlay Lake is supposed to be higher. The phytoplankton biomass ranged from 0.14 to 5.04 mg/l, which indicates very good to poor status of the Inlay Lake phytoplankton.

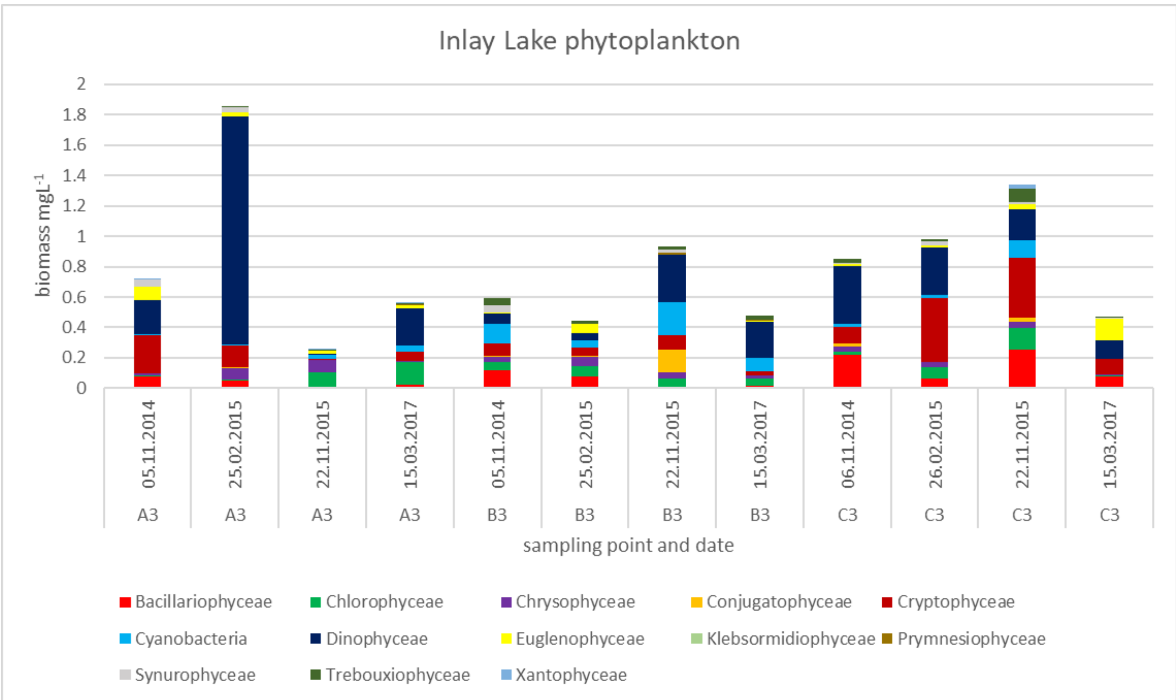

Figure 4.4. Phytoplankton composition and biomass at three central sampling locations A3, B3 and C3 in Inlay Lake in 2014, 2015 and 2017.

At all stations A1-C5 diatoms (Bacillariophyceae), Cryptophyceae, Green algae (Chlorophyceae) Euglenophyceae or Cyanobacteria were the dominating groups. Cyanobacteria were present at all locations but higher biomasses were found only at some of the stations. It is to note that the biomass of Cyanobacteria was always in a range still indicating good water quality. The cyanobacterial species *Microcystis aeruginosa* was found in low amounts at almost all sampling points. Using enzyme linked immunosorbent assay (ELISA), hepatotoxic microcystins were identified in cultures of *M. aeruginosa* isolated from Inlay Lake. Figure 4.5 shows *Microcystis aeruginosa,* isolated from Inlay Lake.

The nutrient concentrations measured in Inlay Lake in 2014, 2015 and 2017 suggest that a more extensive growth of phytoplankton, and in particular potential toxic cyanobacteria like *M. aeruginosa* (Figure 4.5), can occur.

Inlay Lake, however, is a very shallow and clear lake with a water depth not exceeding 4 m. These conditions support a strong growth of aquatic macrophytes. The macrophytes compete with phytoplankton for available nutrients and are so far preventing a massive growth of phytoplankton and especially nuisance cyanobacteria. Removal of large amounts of aquatic macrophytes from Inlay Lake would probably lead to an increased growth of phytoplankton and have very negative effects for the water quality of the lake.

Figure 4.5. Colony of the microcystin-producing cyanobacterium *Microcystis aeruginosa* isolated from Inlay Lake.

4.3.2 Ecological status of Inlay Lake based on phytoplankton

Based on the phytoplankton biomass and composition, and the trophic index PTI (without chlorophyll), and with Norwegian boundaries (see Table 3.7), we have exemplified the ecological status of Inlay Lake in the years 2014, 2015 and 2017 (Figure 4.6). The majority of the sampling points especially those which are located close to the shore or floating gardens were characterized by a moderate to poor status in the period 2014 - 2017. The sampling stations located more in the lake centre were characterized by a range from very good to poor ecological status. Altogether the ecological status of Inlay lake can be classified as moderate regarding phytoplankton composition and biomass.

Inlay Lake is dominated by intensive growth of aquatic macrophytes, and most likely, a large amount of the available nutrients (TP and TN) is stored in the macrophyte biomass, and not available for phytoplankton growth. The relatively low phytoplankton biomasses found in Inlay Lake in 2014, 2015 and 2017 are therefore probably associated with the massive macrophyte growth. Without aquatic macrophytes, increased nutrient loading will lead to phytoplankton bloom in Inlay Lake.

Most phytoplankton taxa are more or less globally distributed. The use of indicator values, indices and boundaries from Norway seem to be suitable also for assessments in Myanmar. However, the indices and boundaries have to be evaluated and further developed when more data from Myanmar are available.

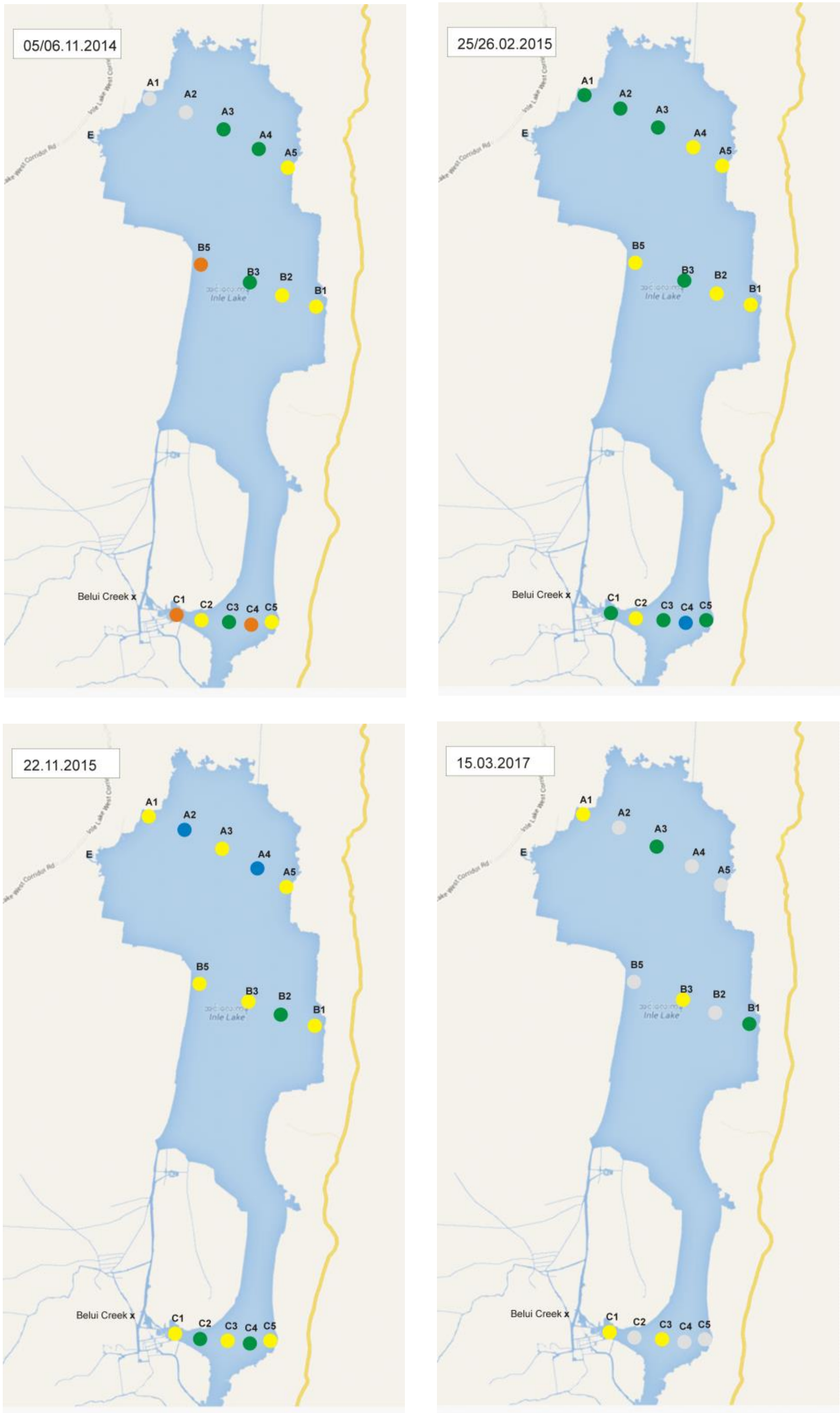

Figure 4.6. Ecological status of Inlay Lake using phytoplankton biomass, PTI index and cyanobacteria biomass. The classification is based on phytoplankton data from Inlay Lake 2014-2017, and exemplified based on Norwegian boundaries in Table 3.7. The evaluation is based on Table 3.1 using the lake type: lowland, calcareous, clear, shallow. Status Blue = very good, green = good, yellow= moderate orange = poor, grey = not sampled.

4.4 Aquatic macrophytes

4.4.1 Species diversity and abundance

The description and analyses of the aquatic macrophytes are based on species lists and semi-quantitative scores from the localities in the transects A, B and C (Figure 3.1).

The species diversity of aquatic macrophytes seems to be high in Inlay Lake, compared to other lakes of similar size and type in Europe and Asia (Rørslett 1991, Penning et al 2009 a,b). In 2014-2017, a total number of 29 species of aquatic macrophytes were recorded in the lake. Among these, 15 elodeids, 8 nymphaeids, 5 lemnids and one charophyte were identified (total species list in Appendix B).

Species frequency (%) and abundance (sum of all semi-quantitative scores) differed from season to season, and from year to year. However, in both years and seasons, the elodeids *Nechamandra alternifolia* and *Potamogeton lucens,* and the lemnid *Eichornia crassipes* dominated the aquatic macrophyte vegetation (Figures 4.7 and 4.8).

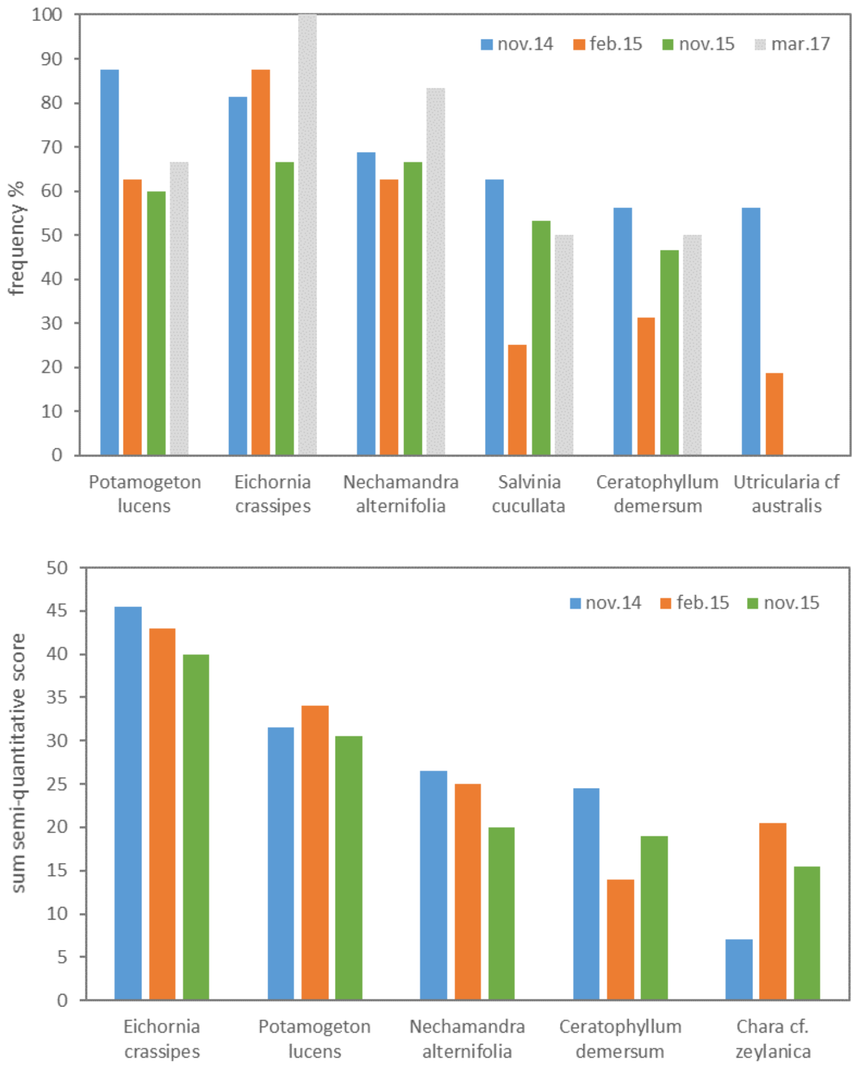

Figure 4.7. Frequency (%) and abundance (sum semi-quantitative scores) of dominating species in Inlay Lake in 2014-2015 (2017). The few data from March 2017 are only included for frequency calculations.

Figure 4.8. The dominating species in Inlay Lake. Upper left: the lemnid *Eichornia crassipes*, upper right: the elodeid *Potamogeton lucens*. Lower picture: the elodeid *Nechamandra alternifolia*. Photos: Andreas Ballot.

The number of species varies among transects and localities, and between year and seasons (Figure 4.9). In general, the localities in the middle of the lake had fewer free-floating species (lemnids), mainly because of wind stress. The number of species was lower after the wet season (i.e. November), compared to after the dry period (February). The macrophytes seemed to be in better condition after the wet season (i.e. November), compared to the dry period (February). In February 2015 and also in March 2017, the coverage of periphyton algae on sediment and plants was higher than in the November periods, which effect the light and nutrient conditions for macrophytes.

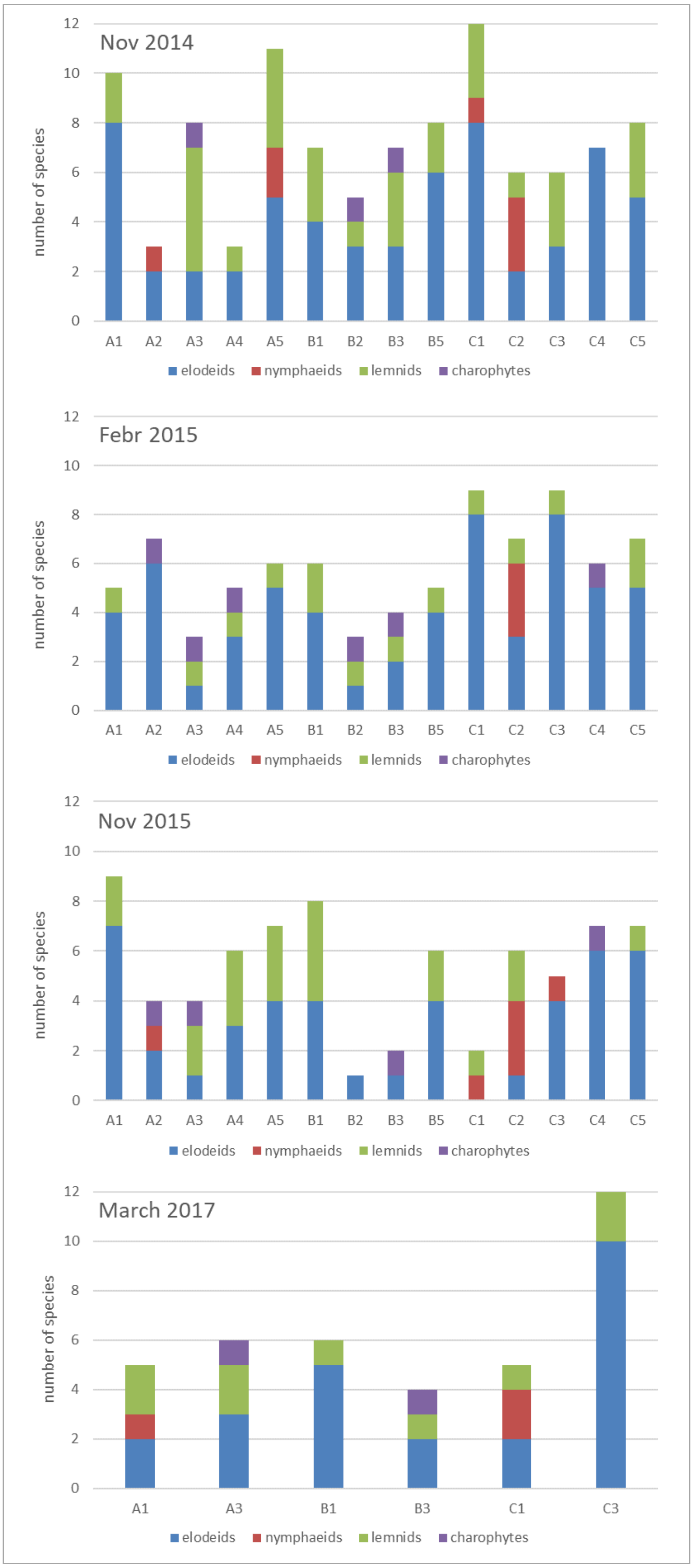

Figure 4.9. Aquatic macrophytes at the different localities and dates in Inlay Lake. Number of species within each lifeform group. Only localities from the main transects A, B and C are included.

In temperate areas the growing season for aquatic macrophytes only last for 6-7 months. The climate in the rest of the year is often too cold to support macrophyte growth. In these areas, a survey once a year is generally enough to get an overview of the diversity and abundance of aquatic macrophytes. In tropical areas, where the climate support macrophyte growth the whole year, the growing season can vary between species, and some of the less frequent species are absent or have small abundance in part of the year. To get a good overview of the diversity and abundance of aquatic macrophytes in tropical eutrophic lakes it seems to be necessary to survey twice a year, and several years in a row.

4.4.2 Ecological status of Inlay Lake based on aquatic macrophytes

In this chapter, we present the ecological status of aquatic macrophytes in Inlay Lake, based on the three possible indices, suggested by Mjelde et al (2017), also see chapter 3.2.3. These indices and boundaries are used here as examples of ecological status assessments. And as shown, the ecological status of Inlay lake varies considerably, depending on the various indices. Therefore, their usefulness in Myanmar lakes have to be evaluated by Myanmar experts, and indices and boundaries for Myanmar have to be developed further when more data from the country are available.

Norwegian trophic index - TIc

Based on the preliminary species sensitivity for Myanmar species, and using the suggested Norwegian trophic index and boundaries, the status of aquatic macrophytes in Inlay Lake is classified as poor (Table 4.5). The status seems to become worse from November 2014 to November 2015, however, still in the same status class.

Table 4.5. Ecological status of aquatic macrophytes in Inlay Lake in 2014-2015
Based on the TIc-index and the boundaries in Table 3.9. Inlay Lake is lake type 301: high alkalinity, clear. Orange = poor status.

Period	TIc value	Status
November 2014	-20.8	poor
February 2015	-23.8	poor
November 2015	-28.6	poor

The TIc-index indicates that the aquatic macrophytes in Inlay Lake are dominated by tolerant species, which give a negative value, and poor status (based on Norwegian boundaries). The result from this index is of course uncertain due to the fact that it is based on preliminary species sensitivities and that Norwegian boundaries are used. If such an index is chosen for Myanmar assessment, the species sensitivity has to be further developed and boundaries exclusively for Myanmar lakes has to be developed.

Relative abundance index (RA index)

Based on the suggested relative abundance metrics (average of three metrics), the status of aquatic macrophytes in Inlay Lake was classified as poor in November 2014, and moderate in February and November 2015, see Table 4.6.

Table 4.6. Ecological status of aquatic macrophytes in Inlay Lake in 2014 and 2015.
Based on a RA-index (relative abundance), see Table 3.10. Yellow = moderate status, orange = poor status.

Period	RA value	Status
November 2014	2.4	poor
February 2015	2.8	moderate
November 2015	2.5	moderate

This relative abundance index includes the sensitive lifeform group charophytes and the tolerant group lemnids. It is an overall agreement of the sensitivities of these lifeform groups, which make such an index more robust than the TIc-index, and may be more suitable for Myanmar assessment at this stage.

However, if this index or a similar one is chosen, it has to be further developed and boundaries exclusively for Myanmar lakes have to be developed.

Conclusion

The distribution of aquatic macrophytes in different lake types in Myanmar is poorly known, and no agreement exists about sensitivities o the species present in Inlay Lake. We therefor suggest to continue developing an index similar to the Relative abundance index (RA index).

4.5 Conclusion remarks on ecological status assessment in Inlay lake

In chapter 4.1-4.4 we have presented some physico-chemistry and biological data conducted from Inlay lake in 2014-2017. We have tested some ecological status indices, suggested by Mjelde et al. (2017), with data from Inlay lake.

When indies and boundaries for Myanmar lakes are established, a final ecological status in the lake can be determined, based on the different indices for the biological elements, and the supporting physico-chemical elements, and following the 'one-out, all-out' principle (i.e., the worst status of the biological elements used in the assessment determines the final status of the water body). The supporting physico-chemical elements can only influence the status down to moderate, while only biological elements can determine poor or bad status.

However, on this stage the ecological assessments presented here is just an example, and final ecological status for the lake cannot be determined. Establishing a correct classification system for Myanmar requires information about species distribution in country, and their sensitivity to pressures, in addition to data about existing lake types and water chemistry. We highly recommend starting the collection of data from other lakes in different regions of Myanmar. The chosen lakes should represent different lake types (natural lakes and reservoirs, high and low alkalinity lakes, etc.) with expected different biodiversity of phytoplankton and aquatic macrophytes, and representing different water quality. Data from these additional lakes will give important information about the distribution of species along the main gradients, such as alkalinity, nutrient, latitude, altitude, etc. Together with data from Inlay Lake, these data will be essential to establish indices and boundaries for assessing ecological status for phytoplankton and aquatic macrophytes in lakes in Myanmar.

5. Suggested monitoring programme for Inlay Lake

5.1 Quality elements and frequency

For the monitoring programme in Inlay Lake we recommend to continue with the biological elements phytoplankton (including chlorophyll) and aquatic macrophytes (Table 5.1).

In addition, the following physico-chemical parameters should be included: oxygen, pH, conductivity, calcium, colour, turbidity, total phosphorous (TP), PO_4, total nitrogen (TN), NO_3, NH_4, and total organic carbon (TOC).

To detect pollutants from the floating gardens, we suggest sampling for organic pollutants in the sediments once a month; but *only* during months when farmers spray with pesticides. Knowing the type of pesticide will facilitate the accuracy of the analysis. Samples should be sediment samples rather than water samples since organic pollutants tend to accumulate in sediment and/or biota and may not be detectable in water. To monitor effects from small industries, sampling close to the outlet and downstream the industries for the analysis of metals is needed (see also chapter 3.2.1 on Priority Substances). Sewage from villages will mainly refer to nutrient and bacteria impact. Monitoring of bacteria levels need to occur regularly, but more frequent in the dry, summer season when particularly high levels of bacteria can be expected (Presentation Taungyi university 2016).

Monthly water level measurements should be included. In addition, a bathymetric map (showing the depths of the lake) should be created.

Table 5.1. Recommended quality elements and frequency for surveillance monitoring in Inlay Lake. The elements and frequency are in accordance with the EU WFD suggestions.

Quality elements	Suggested for Inlay Lake (and other lakes in Myanmar)
Phytoplankton - Chlorophyll a (µg/l) - Total algal biomass (mg/l) - Species composition - Cyanobacterial biomass (mg/l)	monthly first year, bimonthly later years
Aquatic macrophytes - abundance - species composition	twice a year in 2 years, repetition period after 3 years
Fish - abundance - species composition	has to be discussed
Hydrology morphology: -water level measurements -depth measurements	 every month once and repetition after 10 years
Physical-chemical elements	monthly first year, bimonthly later years
Priority substances	at selected sites, depending on industrial or other use of substances.

In flowing rivers to Inlay Lake
In addition, we suggest water samples for physico-chemical analyses from the main inflowing rivers and the lake outlet every month in a 2-year period, according to Table 5.2. At the same time, water flow measurements should be included. Suggested physio-chemical parameters are: oxygen, pH, conductivity, calcium, colour, turbidity, total phosphorous (TP), PO_4, total nitrogen (TN), NO_3, NH_4, and total organic carbon (TOC).

Table 5.2. Recommended monitoring in the inflowing rivers to Inlay Lake.

Quality elements	Frequency	Repetition
Macroinvertebrates	in a second phase	
Fish	in a later phase	
Periphyton	has to be decided later	
Physical-chemical elements	every month in a 2-year period	after 3 years
Priority substances	has to be decided later	to be decided
Hydro-morphology: -water flow	every month in a 2-year period	after 3 years

5.2 Localities

The original number of 14 sampling localities (Figure 5.1) can be reduced to 6 for water chemistry and phytoplankton. The distribution of aquatic macrophytes can vary between the localities, depending on the character and condition of the local habitats. All the original sampling localities should be maintained for aquatic macrophytes.

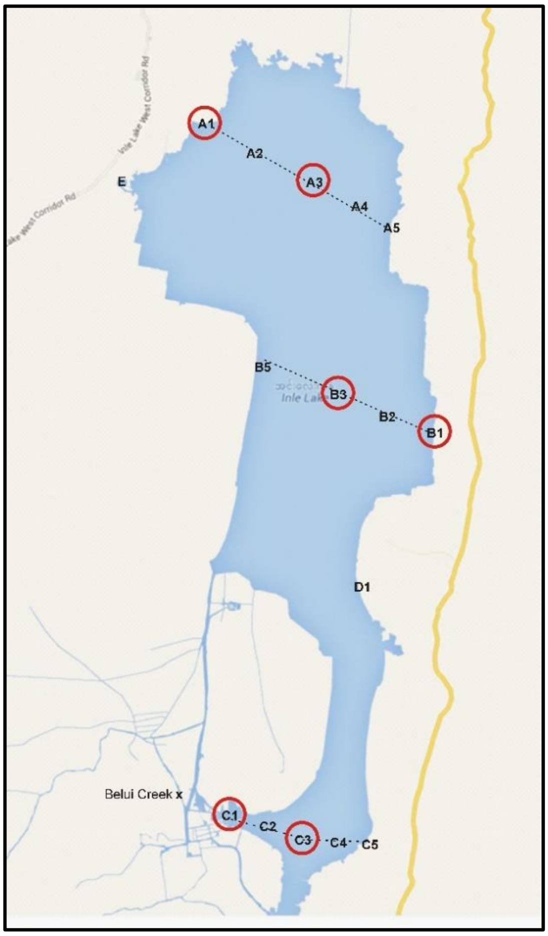

Figure 5.1. Suggested localities for surveillance monitoring programme in Inlay Lake. In total 14 localities for aquatic macrophytes and 6 localities for phytoplankton and water samples (red circles).

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Appendix A.

Normative definitions for high, good and moderate status for phytoplankton and macrophytes in lakes.
From: DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000: Establishing a framework for Community action in the field of water policy

Status	Phytoplankton	Aquatic macrophytes
High	The taxonomic composition of phytoplankton corresponds totally or nearly totally to undisturbed conditions. The average phytoplankton abundance is wholly consistent with the type-specific physio-chemical conditions and is not such as to significantly alter the type-specific transparency conditions. Planktonic blooms occur at a frequency and intensity which is consistent with the type-specific physicochemical conditions	The taxonomic composition corresponds totally or nearly totally to undisturbed conditions. There are no detectable changes in the average macrophyte abundance.
Good	There are slight changes in the composition and abundance of planktonic taxa compared to the type-specific communities. Such changes do not indicate any accelerated growth of algae resulting in undesirable disturbances to the balance of organisms present in the water body or to the physio-chemical quality of the water or sediment. A slight increase in the frequency and intensity of the type-specific planktonic blooms may occur.	There are slight changes in the composition and abundance of macrophyte taxa compared to the type-specific communities. Such changes do not indicate any accelerated growth resulting in undesirable disturbances to the balance of organisms present in the water body or to the physio-chemical quality of the water or sediment.
Moderate	The composition of planktonic taxa differs moderately from the type-specific communities. Abundance is moderately disturbed and may be such as to produce a significant undesirable disturbance in the values of other biological and physio-chemical quality elements. A moderate increase in the frequency and intensity of planktonic blooms may occur. Persistent blooms may occur during summer months.	The composition of macrophyte taxa differs moderately from the type-specific community and is significantly more distorted than at good status. Moderate changes in the average macrophyte abundance are evident.

Appendix B. **Species lists**

Appendix Table B1. Phytoplankton composition in Inlay Lake in Inlay Lake in November 2014, February and November 2015, and March 2017.

Appendix Table B2. Aquatic macrophytes in Inlay Lake in November 2014, February and November 2015 and March 2017.

Appendix Table B1. Phytoplankton composition in Inlay Lake in November 2014, February and November 2015 and March 2017. Legend: + = sporadic, ++ = frequent, +++ = dominant.

Taxon	A1 25.02. 2015	A1 22.11. 2015	A1 15.03. 2017	A2 25.02 2015	A2 22.11. 2015	A3 05.11. 2014	A3 25.02. 2015	A3 22.11. 2015	A3 15.03. 2017	A4 05.11. 2014	A4 25.02. 2015	A4 22.11. 2015	A5 05.11. 2014	A5 25.02. 2015	A5 22.11. 2015
Domain Eubacteria															
Division Cyanobacteria (Cyanoprokaryota)															
Anabaenopsis V.V.Miller															
Aphanocapsa spp. C. Nägeli		+++	+++	+++	+++	+	+	++	+++	++	++	++	++	+	+++
Aphanothece sp. C. Nägeli		+	+++		++		++	++	+++		+			+	+
Chroococcus sp. Nägeli					+									++	++
Chroococcus limneticus Lemmerm.												+			
Chroococcus minimus (Keissler) Lemmermann													++	+	
Chrysosporum E.Zapomelová, O.Skaácelová, P.Pumann, R.Kopp & E.Janecek			+												
Cylindrospermopsis curvispora M.Watanabe		++											+		+
Dolichospermum (Ralfs ex Bornet & Flahault) P.Wacklin, L.Hoffmann & J.Komárek	+			++			+		+						
Geitlerinema (Anagnostidis & Komárek) Anagnostidis															
Limnothrix redekei (Goor) Meffert					+		+		+						
Merismopedia punctata Meyen		++			+++	++		+	+						
Merismopedia tenuissima Lemmermann		++	+	+	++	+		+	++				++		+
Microcystis aeruginosa (Kützing) Kützing					++	++					+++			+	
Microcystis firma (Kützing) Schmidle				++											
Microcystis sp. (Kützing) Kützing	++		+	+++						++		+			
Microcystis viridis (A.Braun) Lemmermann															
Oscillatoria Vaucher ex Gomont											+				
unknown Oscillatoriales	+						++						+		
Phormidium sp. Kützing ex Gomont												+			
Planktolyngbya cf. brevicellularis G.Cronberg & Komárek							+	+		+	+				
Planktolyngbya Anagnostidis & Komárek				+++	++				+			+			
Planktothrix cryptovaginata (Schkorbatov) Anagnostidis & Komárek															

Appendix Table B1. (cont.).

Taxon	A1 25.02. 2015	A1 22.11. 2015	A1 15.03. 2017	A2 25.02 2015	A2 22.11. 2015	A3 05.11. 2014	A3 25.02. 2015	A3 22.11. 2015	A3 15.03. 2017	A4 05.11. 2014	A4 25.02. 2015	A4 22.11. 2015	A5 05.11. 2014	A5 25.02. 2015	A5 22.11. 2015
Planktothrix K.Anagnostidis & J.Komárek		++											+		
Planktothrix pseudaghardii Suda et al.															
Pseudanabaena sp. Lauterborn		+	++	+	+	+		+	+		+	+	+	+	+
Pseudanabaena limnetica (Lemmermann) Komárek	+			+					++						
Rhabdoderma Schmidle & Lauterborn															
Romeria M.Koczwara															
Sphaerospermopsis (Forti) Zapomelová, Jezberová, Hrouzek, Hisem, Reháková & Komárková					+		+								
Spirulina subsalsa Oersted ex Gomont													+		+
Synechococcus C.Nägeli		+		+++		+++					+	+			+
Synechocystis C.Sauvageau						+		+++							
Domain Eukarya															
Class Bacillariophyceae															
Acanthoceras zachariasii (Brun) Simonsen													+		+
Achnanthes Bory		+	+++	+			+	+	++			++			
Amphora sp. Ehrenberg ex Kützing				+		+				+	+				
Amphora ovalis (Kützing) Kützing													+		
Amphora veneta Kützing															
Aulacoseira granulata (Ehrenberg) Simonsen		++									+++				
Aulacoseira granulata var. *angustissima* (Otto Müller) Simonsen		+													
Aulacoseira italica (Ehrenberg) Simonsen						+									+
Cocconeis sp. Ehrenberg	++	+	+						+					+	
Cyclotella (Kützing) Brébisson		++	++	++	+						++	+			+
Cymbella sp. C.Agardh	+	++	+++				+	+	+	+					
Diatoma Bory													+		
Epithemia Kützing		+	+									+			
Eunotia bilunaris (Ehrenberg) Schaarschmidt															

Appendix Table B1. (cont.).

Taxon	A1 25.02. 2015	A1 22.11. 2015	A1 15.03. 2017	A2 25.02 2015	A2 22.11. 2015	A3 05.11. 2014	A3 25.02. 2015	A3 22.11. 2015	A3 15.03. 2017	A4 05.11. 2014	A4 25.02. 2015	A4 22.11. 2015	A5 05.11. 2014	A5 25.02. 2015	A5 22.11. 2015
Eunotia sp. Ehrenberg	+														
Fragilaria capucina Desmazières			+												
Fragilaria fasciculata (C.Agardh) Lange-Bertalot				+											
Fragilaria sp. Lyngbye	++	+													
Fragilaria ulna (Nitzsch) Lange-Bertalot			+++											++	
Frustulia vulgaris (Thwaites) De Toni															
Gomphonema affine Kützing															
Gomphonema parvulum (Kützing) Kützing															
Gomphonema sp. Ehrenberg	+	+	++	++	+	+	+	+	+++	+		+	+	++	
Gomphonema truncatum Ehrenberg															
Gyrosigma Hassall															
Melosira varians C.Agardh										+					
Navicula Bory	++	+				+			+		+		+	+	+
Navicula captoradiata														+	
Navicula cryptocephala Kützing															
Neidium Pfitzer	+										+		+		
Nitzschia acicularis			+												
Nitzschia constricta (Kützing) Ralfs															
Nitzschia palea (Kützing) W.Smith			+								+		+		++
Nitzschia cf. *sigmoidea* (Nitzsch) W.Smith															
Nitzschia subacicularis Hustedt, nom. inval.															
Nitzschia Hassall							++						+		
Pinnularia sp. Ehrenberg	+				+				+				+		
Rhopalodia Otto Müller				+											
Rhopalodia gibberula (Ehrenberg) Otto Müller															
Rhizosolenia longiseta O.Zacharias										++					
Surirella Ehrenberg													+		
Surirella cf. *elegans* Ehrenberg															
Surirella linearis W.Smith															

Appendix Table B1. (cont.).

Taxon	A1 25.02. 2015	A1 22.11. 2015	A1 15.03. 2017	A2 25.02 2015	A2 22.11. 2015	A3 05.11. 2014	A3 25.02. 2015	A3 22.11. 2015	A3 15.03. 2017	A4 05.11. 2014	A4 25.02. 2015	A4 22.11. 2015	A5 05.11. 2014	A5 25.02. 2015	A5 22.11. 2015
Tabellaria Ehrenb. ex Kütz.															
Tabellaria flocculosa (Roth) Kützing															
unknown Bacillariophyceae															
Class Conjugatophyceae															
Arthrodesmus Ehrenberg ex Ralfs				+											
Closterium spp. Nitzsch ex Ralfs			++												+
Cosmarium Corda ex Ralfs			+							+			++		
Cosmarium garrolense J.Roy & Bisset															
Cosmarium hammeri var. *homalodermum* (Nordstedt) West & G.S.West															
Cosmarium pachydermum P.Lundell							+								
Staurastrum cf. avicula Brébisson			+												
Staurastrum spp. Meyen ex Ralfs		+									+				
Class Chlorophyceae															
Ankistrodesmus Chorda															
Ankistrodesmus fusiformis Corda															
Carteria Diesing	+		++	+		+								+	+
Chlamydomonas sp. Ehrenberg		+++	+	++		++	++	+	++	+	+		++	++	+
Coelastrum astroideum De Notaris															
Coelastrum microporum Nägeli				+				+							
Coelastrum polychordum (Korshikov) Hindák														+	
Coelastrum pseudomicroporum Korshikov			+												
Coelastrum reticulatum (P.A.Dangeard) Senn		+		+				+			+++			+	
Coenochloris hindakii Komárek					++										
Coenochloris Korshikov			++						++						+
Chlorolobion braunii (Nägeli) Komárek															
Desmatractum delicatissimum Korshikov			+	+	+										
Desmodesmus quadricauda (Turpin) Brébisson				+		+	+		+	+	+	+	+	+	

Appendix Table B1. (cont.).

Taxon	A1 25.02. 2015	A1 22.11. 2015	A1 15.03. 2017	A2 25.02 2015	A2 22.11. 2015	A3 05.11. 2014	A3 25.02. 2015	A3 22.11. 2015	A3 15.03. 2017	A4 05.11. 2014	A4 25.02. 2015	A4 22.11. 2015	A5 05.11. 2014	A5 25.02. 2015	A5 22.11. 2015
Eudorina elegans Ehrenberg															
Eutetramorus Walton															
Eutetramorus fottii (Hindák) Komárek															
Golenkinia brevispina Korshikov			+	+		+		++	+++	+	++		+	+	
Golenkinia radiata Chodat				+											
Kirchneriella contorta (Schmidle) Bohlin				+											
Kirchneriella dianae (Bohlin) Comas Gonzalez			+												
Kirchneriella lunaris (Kirchner) Möbius				+											
Kirchneriella microscopica Nygaard															
Kirchneriella obesa (West) West & G.S.West										+					
Kirchneriella sinensis Skvortzov										+					
Kirchneriella subcapitata Korshikov									+						
Kirchneriella Schmidle															
Monoraphidium circinale (Nygaard) Nygaard	+	+++	+++	++	++	+	+	++	++	+	+	+			
Monoraphidium contortum (Thuret) Komárková-Legnerová		++						+		+		+	+		
Monoraphidium convolutum (Corda) Komárková-Legnerová						+								+	+++
Monoraphidium komarkovae Nygaard						+		+							
Monoraphidium minutum (Nägeli) Komárková-Legnerová		+++			+			+					+++	+	+++
Monoraphidium Komárková-Legnerová															
Pediastrum duplex Meyen			+												
Pediastrum simplex Meyen		+	+	++			+	+	+	+	+	+		++	+
Pediastrum simplex var. *echinulatum* Wittrock															
Pediastrum tetras (Ehrenberg) Ralfs															
Quadrigula lacustris (Chodat) G.M.Smith															
Scenedesmus Meyen		+			++				+++						++
Scenedesmus acutus Meyen															
Scenedesmus acuminatus (Lagerheim) Chodat											+	+			+

Appendix Table B1. (cont.).

Taxon	A1 25.02. 2015	A1 22.11. 2015	A1 15.03. 2017	A2 25.02 2015	A2 22.11. 2015	A3 05.11. 2014	A3 25.02. 2015	A3 22.11. 2015	A3 15.03. 2017	A4 05.11. 2014	A4 25.02. 2015	A4 22.11. 2015	A5 05.11. 2014	A5 25.02. 2015	A5 22.11. 2015
Scenedesmus bicaudatus Dedusenko															
Scenedesmus calyptratus Comas Gonzáles			+	++											
Scenedesmus ecornis (Ehrenberg) Chodat		+		++		+	+	+		+	++	++			
Scenedesmus linearis Komárek		+													
Scenedesmus dimorphus (Turpin) Kützing												+			
Scenedesmus disciformis (Chodat) Fott & Komárek											+				
Scenedesmus intermedius Chodat															
Scenedesmus obtusus Meyen				+											
Scenedesmus pecsensis Uherkovich															
Scenedesmus sempervirens Chodat			+						+						
Scenedesmus spinosus Chodat					+										
Scenedesmus verrucosus Y.V.Roll									+						
Schroederia planctonica (Skuja) Philipose															
Sorastrum Kützing			+		+				+						
Spermatozopsis exultans Korshikov															
Tetraedron caudatum (Corda) Hansgirg		+	+	++	++		+		++	+	++				
Tetraëdron incus (Teiling) G.M.Smith		+										+			
Tetraëdron mediocris Hindák															
Tetraedron minimum (A.Braun) Hansgirg									+	+	+		+	+	+
Tetrastrum heteracanthum (Nordstedt) Chodat															
Tetrastrum komarekii Hindák	+	+	+		++				+					+	+
Tetrastrum punctatum (Schmidle) Ahlstrom & Tiffany															
Tetrastrum triacanthum Korshikov															
Tetrastrum triangulare (Chodat) Komárek				+									+		
Treubaria triappendiculata C.Bernard								+				+			
Westella botryoides (West) De Wildeman			++		+				+						
Willea rectangularis (A.Braun) D.M.John, M.J.Wynne & P.M.Tsarenko															
Willea vilhelmii (Fott) Komárek						+					++				
unknown Chlorophyceae	++	++		++								++	++		

Appendix Table B1. (cont.).

Taxon	A1 25.02. 2015	A1 22.11. 2015	A1 15.03. 2017	A2 25.02 2015	A2 22.11. 2015	A3 05.11. 2014	A3 25.02. 2015	A3 22.11. 2015	A3 15.03. 2017	A4 05.11. 2014	A4 25.02. 2015	A4 22.11. 2015	A5 05.11. 2014	A5 25.02. 2015	A5 22.11. 2015
Class Trebouxiophyceae															
Actinastrum gracillimum G.M.Smith															
Actinastrum hantzschii Lagerheim													+		
Botryococcus terribilis Komárek & Marvan							+								
Closteriopsis acicularis (Chodat) J.H.Belcher & Swale															
Crucigenia tetrapedia (Kirchner) Kuntze		+						+							
Crucigeniella apiculata (Lemmermann) Komárek												+			
Crucigeniella pulchra (West & G.S.West) Komárek			+												
Crucigeniella crucifera (Wolle) Komárek		+		+	+						+			+	+
Crucigeniella rectangularis (Nägeli) Komárek															
Dichotomococcus Korshikov, 1928															
Dictyosphaerium ehrenbergianum Nägeli		+													
Dictyosphaerium subsolitarium Van Goor															
Dictyosphaerium Nägeli															
Franceia elongata Korshikov															
Franceia javanica (C.Bernard) Hortobágyi															
Golenkiniopsis longispina (Korshikov) Korshikov			+												
Golenkiniopsis solitaria (Korshikov) Korshikov															+
Golenkiniopsis parvula (Woronichin) Korshikov												++			
Lagerheimia chodatii C.Bernard															
Lagerheimia ciliata (Lagerheim) Chodat															
Lagerheimia cingula G.M.Smith															
Lagerheimia genevensis (Chodat) Chodat											+				
Lagerheimia quadriseta (Lemmermann) G.M.Smith															
Lagerheimia subsalsa Lemmermann															
Micractinium pusillum Fresenius															
Nephrocytium agardhianum Nägeli															
Nephrocytium limneticum (G.M.Smith) G.M.Smith															

Appendix Table B1. (cont.).

Taxon	A1 25.02. 2015	A1 22.11. 2015	A1 15.03. 2017	A2 25.02 2015	A2 22.11. 2015	A3 05.11. 2014	A3 25.02. 2015	A3 22.11. 2015	A3 15.03. 2017	A4 05.11. 2014	A4 25.02. 2015	A4 22.11. 2015	A5 05.11. 2014	A5 25.02. 2015	A5 22.11. 2015
Nephrocytium schilleri (Kammerer) Comas González															
Nephrocytium Nägeli															+
Oocystis sp Nägeli ex A.Braun		+	+		++			++			++	+	+		+
Oocystis nephrocytioides Fott & Cado															
Planctonema lauterbornii Schmidle															
Tetrachlorella Korshikov, 1939													+		
Tetrachlorella alternans (G.M.Smith) Korshikov															
Class Klebsormidiophyceae															
Elakatothrix viridis (J.W.Snow) Printz															+
Class Cryptophceae															
Cryptomonas Ehrenb.	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
Class Dinophyceae															
Ceratium hirundinella (O.F.Müller) Dujardin							+				++			+	
Glenodinium Ehrenberg															
Gymnodinium F.Stein	+	+	+	++	+		+				+	+	+++		
Gymnodinium simplex (Lohmann) Kofoid & Swezy		+	+			++	+++		+++						
Gymnodinium *uberrimum* (G.J.Allman) Kofoid & Swezy											+				
Peridiniopsis Lemmermann						+++	+++	++							
Peridinium Ehrenberg	++	+	++								+	+++	+	++	+
Peridinium brevipes Paulsen						+	+++								
Peridinium bipes Stein		+		++	++				+++			++			
Peridinium willei Huitfeldt-Kaas											+				
Class Euglenophyceae															
Euglena acus (O.F.Müller) Ehrenberg		++				+						+			
Euglena cf. *viridis* (O.F.Müller) Ehrenberg															

Appendix Table B1. (cont.).

Taxon	A1 25.02. 2015	A1 22.11. 2015	A1 15.03. 2017	A2 25.02 2015	A2 22.11. 2015	A3 05.11. 2014	A3 25.02. 2015	A3 22.11. 2015	A3 15.03. 2017	A4 05.11. 2014	A4 25.02. 2015	A4 22.11. 2015	A5 05.11. 2014	A5 25.02. 2015	A5 22.11. 2015
Euglena spp. Ehrenberg	+	++	+			+	+	++	++			+	+++	+	+
Lepocinclis capito Wehrle													+		
Lepocinclis constricta Matvienko															
Lepocinclis elongata (Swirenko) Conrad													+		
Lepocinclis cf. *ovum* (Ehrenberg) Lemmermann			+				+								
Lepocinclis texta (Dujardin) Lemmermann	+		+												
Lepocinclis truncata A.M.Cunha	+												+		
Lepocinclis Perty		+											++		
Notosolenus A.C.Stokes									+			+			
Phacus acuminatus Stokes													+		
Phacus helikoides Pochmann															
Phacus cf *lismorensis*															
Phacus longicauda (Ehrenberg) Dujardin		+	+			+		+					+		
Phacus tortus (Lemmermann) Skvortzov															
Phacus sp. Dujardin		+	++			++		+						+	+
Strombomonas verrucosa (E.Daday) Deflandre															
Trachelomonas Ehrenberg						+				+			+++		
Trachelomonas sydneyensis Playfair															
Trachelomonas subdenticulata (Playfair) W.Conrad															
Trachelomonas superba Svirenko															
Trachelomonas volvocina (Ehrenberg) Ehrenberg		+		++			+				+			++	
Trachelomonas volvocinopsis Svirenko															
Class Chrysophyceae															
Bitrichia chodatii (Reverdin) Chodat						+		++						+	
Bitrichia cf. *phaseolus* (Fott) Bourr.												+			
unknown Chrysophceae	+++	+								+++				+++	+++
Chromulina L.Cienkowsky	+	++	+++	+++	++	++	+++	+++	+++		+++	++	+++		

Appendix Table B1. (cont.).

Taxon	A1 25.02. 2015	A1 22.11. 2015	A1 15.03. 2017	A2 25.02 2015	A2 22.11. 2015	A3 05.11. 2014	A3 25.02. 2015	A3 22.11. 2015	A3 15.03. 2017	A4 05.11. 2014	A4 25.02. 2015	A4 22.11. 2015	A5 05.11. 2014	A5 25.02. 2015	A5 22.11. 2015
Chrysidiastrum catenatum Lauterborn					+										
Chrysococcus G.A.Klebs															
Dinobryon bavaricum Imhof		+		+	++		++				++	+		++	+
Dinobryon crenulatum West & G.S.West		+	+	+				+	+			+		+	
Dinobryon divergens O.E.Imhof		+			++	+	++				++				
Dinobryon divergens var. *schauinslandii* (Lemmermann) Brunnthaler				+											
Dinobryon sociale (Ehrenberg) Ehrenberg													+		
Dinobryon sertularia Ehrenberg				+	+	+	+	+			+	++		+	
Dinobryon stokesii Lemmermann															
Dinobryon suecicum Lemmermann															
Epipyxis lauterbornii (Lemmermann) D.K.Hilliard & Asmund															
Ochromonas Vysotskij sp.		+	+	+	+++	++	+++	+	++		++	+	+	++	
Ochromonas polychrysis Skuja															
Ochromonas reptans Conrad					+										
Kephyrion Pascher					+										
Pseudokephyrion Pascher				++			+++								
Stokesiella acuminata (A.Stokes) Lemmermann															
Class Bicosoecaceae															
Bicosoeca eurystoma Hilliard									+						
Class Prymnesiophyceae (Haptophyceae)															
Chrysochromulina parva Lackey		+	++	+++	+++		+	+	+++		++				
Class Synurophyceae															
Mallomonas caudata Iwanoff [Ivanov]															
Mallomonas cf. *elegans* Lemmermann						+									
Mallomonas elongata Reverdin							+								
Mallomonas schwemmlei Glenk															

Appendix Table B1. (cont.).

Taxon	A1 25.02. 2015	A1 22.11. 2015	A1 15.03. 2017	A2 25.02 2015	A2 22.11. 2015	A3 05.11. 2014	A3 25.02. 2015	A3 22.11. 2015	A3 15.03. 2017	A4 05.11. 2014	A4 25.02. 2015	A4 22.11. 2015	A5 05.11. 2014	A5 25.02. 2015	A5 22.11. 2015
Mallomonas sp. Perty	+	++		+	+	+	+	+	++	+	++		+		
Mallomonas cf. *majorensis* Skuja				+											
Microglena Ehrenberg															
Class Xanthophyceae Eustigmatophyceae															
Centritractus belonophorus (Schmidle) Lemmermann								+					+		+
Centritractus ellipsoideus Starmach		+	++			+		+				+	+		
Centritractus africanus F.E.Fritsch & M.F.Rich											++			+	
Ophiocytium capitatum Wolle												+			
Tetraëdriella regularis (Kützing) Fott											+				
Tetraëdriella polychloris Skuja															
Goniochloris Geitler															
Goniochloris fallax Fott	+	+						+	+				+	+	+
Goniochloris contorta (Bourrelly) H.Ettl															
Goniochloris smithii (Bourrelly) Fott		+													
Pseudostaurastrum lobulatum (Nägeli) Bourrelly													+		
Pseudostaurastrum hastatum (Reinsch) Chodat															

Appendix Table B1. (cont.).

Taxon	B1 05.11. 2014	B1 25.02. 2015	B1 22.11. 2015	B1 15.03. 2017	B2 05.11. 2014	B2 25.02. 2015	B2 22.11. 2015	B3 05.11. 2014	B3 25.02. 2015	B3 22.11. 2015	B3 17.03. 2017	B5 05.11. 2014	B5 25.0.2. 2015	B5 22.11. 2015
Domain Eubacteria														
Division Cyanobacteria (Cyanoprokaryota)														
Anabaenopsis V.V.Miller				+										
Aphanocapsa spp. C. Nägeli	+++	+++	+++	++	+++	+++	+++	+++	+++	+++	+++	+++	++	+++
Aphanothece sp. C. Nägeli			+++	+	+	+++	+++			+++	++	++	+	+++
Chroococcus sp. Nägeli	++					+++		++	++	++		+		+
Chroococcus limneticus Lemmerm.		+			++		+				+++	+	+	++
Chroococcus minimus (Keissler) Lemmermann					+	+	+++					+	+++	
Chrysosporum E.Zapomelová, O.Skaácelová, P.Pumann, R.Kopp & E.Janecek											++			
Cylindrospermopsis curvispora M.Watanabe	+		+				++					+		++
Dolichospermum (Ralfs ex Bornet & Flahault) P.Wacklin, L.Hoffmann & J.Komárek				+						+				
Geitlerinema (Anagnostidis & Komárek) Anagnostidis														
Limnothrix redekei (Goor) Meffert										+		+		+
Merismopedia punctata Meyen	++					+	+	+++	+	++		++		
Merismopedia tenuissima Lemmermann	++	+	+++		+	+	+++	+++		+++	+		+	+++
Microcystis aeruginosa (Kützing) Kützing		+++			++			++		+++	++	+++	++	++
Microcystis firma (Kützing) Schmidle							+							
Microcystis sp. (Kützing) Kützing	++	+	++			+++	+++							
Microcystis viridis (A.Braun) Lemmermann		+												
Oscillatoria Vaucher ex Gomont														
unknown Oscillatoriales														
Phormidium sp. Kützing ex Gomont												+		
Planktolyngbya cf. brevicellularis G.Cronberg & Komárek	+					+++		+++	++	++		+++		+++
Planktolyngbya Anagnostidis & Komárek			++			++	+				+		+	
Planktothrix K.Anagnostidis & J.Komárek	+											+		
Planktothrix cryptovaginata (Schkorbatov) Anagnostidis & Komárek														
Planktothrix pseudaghardii Suda et al.														
Pseudanabaena sp. Lauterborn				+	+	++			+			++		

Appendix Table B1. (cont.).

Taxon	B1 05.11. 2014	B1 25.02. 2015	B1 22.11. 2015	B1 15.03. 2017	B2 05.11. 2014	B2 25.02. 2015	B2 22.11. 2015	B3 05.11. 2014	B3 25.02. 2015	B3 22.11. 2015	B3 17.03. 2017	B5 05.11. 2014	B5 25.02. 2015	B5 22.11. 2015
Pseudanabaena limnetica (Lemmermann) Komárek			++							+	++	+++		+++
Rhabdoderma Schmidle & Lauterborn														
Romeria M.Koczwara														
Sphaerospermopsis (Forti) Zapomelová, Jezberová, Hrouzek, Hisem, Reháková & Komárková			+			+							+	++
Spirulina subsalsa Oersted ex Gomont														
Synechococcus C.Nägeli			+										+++	
Synechocystis C.Sauvageau														
Domain Eukarya														
Class Bacillariophyceae														
Acanthoceras zachariasii (Brun) Simonsen	+													
Achnanthes Bory				+										+
Amphora sp. Ehrenberg ex Kützing		+	+											
Amphora ovalis (Kützing) Kützing														
Amphora veneta Kützing														
Aulacoseira granulata (Ehrenberg) Simonsen	+				+									+
Aulacoseira granulata var. *angustissima* (Otto Müller) Simonsen														
Aulacoseira italica (Ehrenberg) Simonsen														
Cocconeis sp. Ehrenberg				+	+						+			
Cyclotella (Kützing) Brébisson		+	+++	+	+	+++	+++	++	+	+	+		+	+++
Cymbella sp. C.Agardh									+				+	
Diatoma Bory														
Epithemia Kützing			+	++							+			+
Eunotia bilunaris (Ehrenberg) Schaarschmidt														
Eunotia sp. Ehrenberg													+	
Fragilaria capucina Desmazières														
Fragilaria fasciculata (C.Agardh) Lange-Bertalot													+++	

Appendix Table B1. (cont.).

Taxon	B1 05.11. 2014	B1 25.02. 2015	B1 22.11. 2015	B1 15.03. 2017	B2 05.11. 2014	B2 25.02. 2015	B2 22.11. 2015	B3 05.11. 2014	B3 25.02. 2015	B3 22.11. 2015	B3 17.03. 2017	B5 05.11. 2014	B5 25.02. 2015	B5 22.11. 2015
Fragilaria sp. Lyngbye	+			+						+				
Fragilaria ulna (Nitzsch) Lange-Bertalot			+											+
Frustulia vulgaris (Thwaites) De Toni														
Gomphonema affine Kützing														
Gomphonema parvulum (Kützing) Kützing														
Gomphonema sp. Ehrenberg	++		+	+		++				+		+	+++	+
Gomphonema truncatum Ehrenberg														
Gyrosigma Hassall														
Melosira varians C.Agardh														
Navicula Bory		+			+			+		+	+		++	+
Navicula captoradiata														
Navicula cryptocephala Kützing	+													
Neidium Pfitzer		+												
Nitzschia acicularis														
Nitzschia constricta (Kützing) Ralfs														
Nitzschia palea (Kützing) W.Smith		+	+				+					++	+	+
Nitzschia cf. *sigmoidea* (Nitzsch) W.Smith														
Nitzschia subacicularis Hustedt, nom. inval.														
Nitzschia Hassall		+		+										
Pinnularia sp. Ehrenberg		+						+				+	+	
Rhopalodia Otto Müller														
Rhopalodia gibberula (Ehrenberg) Otto Müller														
Rhizosolenia longiseta O.Zacharias														
Surirella Ehrenberg														
Surirella cf. elegans Ehrenberg								+						
Surirella linearis W.Smith														
Tabellaria Ehrenb. ex Kütz.														
Tabellaria flocculosa (Roth) Kützing													+	
unknown Bacillariophyceae														

Appendix Table B1. (cont.).

Taxon	B1 05.11. 2014	B1 25.02. 2015	B1 22.11. 2015	B1 15.03. 2017	B2 05.11. 2014	B2 25.02. 2015	B2 22.11. 2015	B3 05.11. 2014	B3 25.02. 2015	B3 22.11. 2015	B3 17.03. 2017	B5 05.11. 2014	B5 25.02. 2015	B5 22.11. 2015
Class Conjugatophyceae														
Arthrodesmus Ehrenberg ex Ralfs														
Closterium spp. Nitzsch ex Ralfs					+		+	+		+				
Cosmarium Corda ex Ralfs			+		++		+	+	+	+	+	+		
Cosmarium garrolense J.Roy & Bisset														
Cosmarium hammeri var. *homalodermum* (Nordstedt) West & G.S.West														
Cosmarium *pachydermum* P.Lundell										+				
Staurastrum cf. avicula Brébisson														
Staurastrum spp. Meyen ex Ralfs					+		+	+		+		+		++
Class Chlorophyceae														
Ankistrodesmus Chorda								+						
Ankistrodesmus fusiformis Corda							+							
Carteria Diesing		+++											+	
Chlamydomonas sp. Ehrenberg							+	++	++	+		+	++	+
Coelastrum astroideum De Notaris	+													
Coelastrum microporum Nägeli											+			
Coelastrum polychordum (Korshikov) Hindák					+			++	+					
Coelastrum pseudomicroporum Korshikov														
Coelastrum reticulatum (P.A.Dangeard) Senn		+	+			++				+	+	+	+	+
Coenochloris hindakii Komárek										+				+++
Coenochloris Korshikov			+++				+++			++	++	+++		
Chlorolobion braunii (Nägeli) Komárek														
Desmatractum delicatissimum Korshikov			+		+	++			++					
Desmodesmus quadricauda (Turpin) Brébisson	+	+	+			+	+	+	+	+	+	+		++
Eudorina elegans Ehrenberg											+			+
Eutetramorus Walton														
Eutetramorus fottii (Hindák) Komárek					++									

Appendix Table B1. (cont.).

Taxon	B1 05.11. 2014	B1 25.02. 2015	B1 22.11. 2015	B1 15.03. 2017	B2 05.11. 2014	B2 25.02. 2015	B2 22.11. 2015	B3 05.11. 2014	B3 25.02. 2015	B3 22.11. 2015	B3 17.03. 2017	B5 05.11. 2014	B5 25.02. 2015	B5 22.11. 2015
Golenkinia brevispina Korshikov							++			+	+			
Golenkinia radiata Chodat			++			+++	+++		++	+	+			++
Kirchneriella contorta (Schmidle) Bohlin														+
Kirchneriella dianae (Bohlin) Comas Gonzalez														
Kirchneriella lunaris (Kirchner) Möbius		+												
Kirchneriella microscopica Nygaard								+						
Kirchneriella obesa (West) West & G.S.West														
Kirchneriella sinensis Skvortzov														
Kirchneriella subcapitata Korshikov							+							
Kirchneriella Schmidle														+
Monoraphidium circinale (Nygaard) Nygaard	+++	+++	+++	+	++	++	++		+		++	++	+	+++
Monoraphidium contortum (Thuret) Komárková-Legnerová			+				++	+++	+	+		+		
Monoraphidium convolutum (Corda) Komárková-Legnerová														
Monoraphidium komarkovae Nygaard														
Monoraphidium minutum (Nägeli) Komárková-Legnerová	+++		+	+		+		+	++	++	+	+	+	+++
Monoraphidium Komárková-Legnerová														+
Pediastrum duplex Meyen							+					+		
Pediastrum simplex Meyen	+	++	++	+	+	+++	+	+	+	+		++	+	
Pediastrum simplex var. *echinulatum* Wittrock									+					+
Pediastrum tetras (Ehrenberg) Ralfs			+							+				+
Quadrigula lacustris (Chodat) G.M.Smith														
Scenedesmus Meyen	+		++		+		+++	++	+		++			+++
Scenedesmus acutus Meyen							+			+				
Scenedesmus acuminatus (Lagerheim) Chodat		+				+							+	+
Scenedesmus bicaudatus Dedusenko														
Scenedesmus calyptratus Comas Gonzáles	+									++		++		+
Scenedesmus ecornis (Ehrenberg) Chodat	+				++	++	++	++	++	+++			++	+++
Scenedesmus linearis Komárek			+				+							

Appendix Table B1. (cont.).

Taxon	B1 05.11. 2014	B1 25.02. 2015	B1 22.11. 2015	B1 15.03. 2017	B2 05.11. 2014	B2 25.02. 2015	B2 22.11. 2015	B3 05.11. 2014	B3 25.02. 2015	B3 22.11. 2015	B3 17.03. 2017	B5 05.11. 2014	B5 25.0.2. 2015	B5 22.11. 2 015
Scenedesmus dimorphus (Turpin) Kützing														
Scenedesmus disciformis (Chodat) Fott & Komárek												+		
Scenedesmus intermedius Chodat														
Scenedesmus obtusus Meyen														
Scenedesmus pecsensis Uherkovich														+
Scenedesmus sempervirens Chodat														
Scenedesmus spinosus Chodat														
Scenedesmus verrucosus Y.V.Roll								+						
Schroederia planctonica (Skuja) Philipose										+				
Sorastrum Kützing											+			
Spermatozopsis exultans Korshikov														
Tetraedron caudatum (Corda) Hansgirg	+	++	+		+	+	++	++		+	+	++		++
Tetraëdron incus (Teiling) G.M.Smith														+
Tetraëdron mediocris Hindák									+					
Tetraedron minimum (A.Braun) Hansgirg	+		++		+	++		++	+	+	+	+	+	++
Tetrastrum heteracanthum (Nordstedt) Chodat														+
Tetrastrum komarekii Hindák	+		++			++	+		+	+	++	+	+	+
Tetrastrum punctatum (Schmidle) Ahlstrom & Tiffany	+													
Tetrastrum triacanthum Korshikov														
Tetrastrum triangulare (Chodat) Komárek	+	+	+				++	+						+
Treubaria triappendiculata C.Bernard														
Westella botryoides (West) De Wildeman						+					+			
Willea rectangularis (A.Braun) D.M.John, M.J.Wynne & P.M.Tsarenko														
Willea vilhelmii (Fott) Komárek		++	+			+	+		+	+	+			+
unknown Chlorophyceae														

Appendix Table B1. (cont.).

Taxon	B1 05.11. 2014	B1 25.02. 2015	B1 22.11. 2015	B1 15.03. 2017	B2 05.11. 2014	B2 25.02. 2015	B2 22.11. 2015	B3 05.11. 2014	B3 25.02. 2015	B3 22.11. 2015	B3 17.03. 2017	B5 05.11. 2014	B5 25.02. 2015	B5 22.11. 2015
Class Trebouxiophyceae														
Actinastrum gracillimum G.M.Smith														
Actinastrum hantzschii Lagerheim						+				+				++
Botryococcus terribilis Komárek & Marvan														+
Closteriopsis acicularis (Chodat) J.H.Belcher & Swale														
Crucigenia tetrapedia (Kirchner) Kuntze	++				+			++				+		+
Crucigeniella apiculata (Lemmermann) Komárek							+							
Crucigeniella pulchra (West & G.S.West) Komárek		+												
Crucigeniella crucifera (Wolle) Komárek			+		+					+			+	+
Crucigeniella rectangularis (Nägeli) Komárek														
Dichotomococcus Korshikov, 1928										+				
Dictyosphaerium ehrenbergianum Nägeli														
Dictyosphaerium subsolitarium Van Goor			+								+	+		
Dictyosphaerium Nägeli						+				+				
Franceia elongata Korshikov											+			
Franceia javanica (C.Bernard) Hortobágyi								+++						+
Golenkiniopsis longispina (Korshikov) Korshikov														
Golenkiniopsis solitaria (Korshikov) Korshikov								++						
Golenkiniopsis parvula (Woronichin) Korshikov	++	+++			++							++		
Lagerheimia chodatii C.Bernard														
Lagerheimia ciliata (Lagerheim) Chodat									+					
Lagerheimia cingula G.M.Smith														
Lagerheimia genevensis (Chodat) Chodat			+			+++	++			+	+++			++
Lagerheimia quadriseta (Lemmermann) G.M.Smith														
Lagerheimia subsalsa Lemmermann	++	+++	++		++	+++	+++	++	+		+	++	+	+
Micractinium pusillum Fresenius						+					+			
Nephrocytium agardhianum Nägeli			++						+					+
Nephrocytium limneticum (G.M.Smith) G.M.Smith	+									+	+			

Appendix Table B1. (cont.).

Taxon	B1 05.11. 2014	B1 25.02. 2015	B1 22.11. 2015	B1 15.03. 2017	B2 05.11. 2014	B2 25.02. 2015	B2 22.11. 2015	B3 05.11. 2014	B3 25.02. 2015	B3 22.11. 2015	B3 17.03. 2017	B5 05.11. 2014	B5 25.02. 2015	B5 22.11. 2015
Nephrocytium schilleri (Kammerer) Comas González														+
Nephrocytium Nägeli					+			+					+	
Oocystis sp Nägeli ex A.Braun	+	+			++	++	++	+		++	+++	+		++
Oocystis nephrocytioides Fott & Cado														
Planctonema lauterbornii Schmidle			+				+							
Tetrachlorella Korshikov, 1939														
Tetrachlorella alternans (G.M.Smith) Korshikov														
Class Klebsormidiophyceae														
Elakatothrix viridis (J.W.Snow) Printz					+	+	++		+					
Class Cryptophceae														
Cryptomonas Ehrenb.	+++	+++	+++	+++	++	+	+++	+++	++	+++	+++	++	+++	+++
Class Dinophyceae														
Ceratium hirundinella (O.F.Müller) Dujardin			++		++		+			+	+	+		+
Glenodinium Ehrenberg														
Gymnodinium F.Stein			+	++		+							+	
Gymnodinium simplex (Lohmann) Kofoid & Swezy				+			+				++			+
Gymnodinium *uberrimum* (G.J.Allman) Kofoid & Swezy						+								
Peridiniopsis Lemmermann										+				
Peridinium Ehrenberg	+	+			+	+	+	+	+			+		
Peridinium brevipes Paulsen										++		+		
Peridinium bipes Stein			+	+	+	+++	+				++			
Peridinium willei Huitfeldt-Kaas														
Class Euglenophyceae														
Euglena acus (O.F.Müller) Ehrenberg												+	+	++
Euglena cf. *viridis* (O.F.Müller) Ehrenberg														

Appendix Table B1. (cont.).

Taxon	B1 05.11. 2014	B1 25.02. 2015	B1 22.11. 2015	B1 15.03. 2017	B2 05.11. 2014	B2 25.02. 2015	B2 22.11. 2015	B3 05.11. 2014	B3 25.02. 2015	B3 22.11. 2015	B3 17.03. 2017	B5 05.11. 2014	B5 25.02. 2015	B5 22.11. 2015
Euglena spp. Ehrenberg	+	+	++	++				+	+			++	+	++
Lepocinclis capito Wehrle														
Lepocinclis constricta Matvienko													+	
Lepocinclis elongata (Swirenko) Conrad														
Lepocinclis cf. *ovum* (Ehrenberg) Lemmermann												+	+	+
Lepocinclis texta (Dujardin) Lemmermann			+	+										
Lepocinclis truncata A.M.Cunha	+													
Lepocinclis Perty	+		+					+					+++	
Notosolenus A.C.Stokes														
Phacus acuminatus Stokes														
Phacus helikoides Pochmann													+	
Phacus cf *lismorensis*														
Phacus longicauda (Ehrenberg) Dujardin	+			+				+				+		+
Phacus tortus (Lemmermann) Skvortzov								+						
Phacus sp. Dujardin	+		+	+	+							+	+	+
Strombomonas verrucosa (E.Daday) Deflandre														
Trachelomonas Ehrenberg	+	++											+	
Trachelomonas sydneyensis Playfair														
Trachelomonas subdenticulata (Playfair) W.Conrad														
Trachelomonas superba Svirenko														
Trachelomonas volvocina (Ehrenberg) Ehrenberg												++	++	+
Trachelomonas volvocinopsis Svirenko														
Class Chrysophyceae														
Bitrichia chodatii (Reverdin) Chodat														
Bitrichia cf. *phaseolus* (Fott) Bourr.														
unknown Chrysophceae	++		+											
Chromulina L.Cienkowsky	+++	++	++	+++	+	++	+		+++	+	+++	++	+++	++
Chrysidiastrum catenatum Lauterborn														

Appendix Table B1. (cont.).

Taxon	B1 05.11. 2014	B1 25.02. 2015	B1 22.11. 2015	B1 15.03. 2017	B2 05.11. 2014	B2 25.02. 2015	B2 22.11. 2015	B3 05.11. 2014	B3 25.02. 2015	B3 22.11. 2015	B3 17.03. 2017	B5 05.11. 2014	B5 25.0.2 2015	B5 22.11. 2015
Chrysococcus G.A.Klebs										++			++	
Dinobryon bavaricum Imhof	+		+	++		+	++		+	++	+			
Dinobryon crenulatum West & G.S.West	+	+	+	+	+	+	+	+	+	++	++	+	+	++
Dinobryon divergens O.E.Imhof		+	+		+	+	++		+++	++	++	+	+	+
Dinobryon divergens var. *schauinslandii* (Lemmermann) Brunnthaler				+										
Dinobryon sociale (Ehrenberg) Ehrenberg								++						
Dinobryon sertularia Ehrenberg		+	+++		++	+	+			++			+	++
Dinobryon stokesii Lemmermann														
Dinobryon suecicum Lemmermann		+												
Epipyxis lauterbornii (Lemmermann) D.K.Hilliard & Asmund						++								
Ochromonas Vysotskij sp.		+++	++	++	+	+	++		++	++	+++	++	+	++
Ochromonas polychrysis Skuja														
Ochromonas reptans Conrad														
Kephyrion Pascher										+	+			
Pseudokephyrion Pascher														
Stokesiella acuminata (A.Stokes) Lemmermann														
Class Bicosoecaceae														
Bicosoeca eurystoma Hilliard														
Class Prymnesiophyceae (Haptophyceae)														
Chrysochromulina parva Lackey			++	+++		++	++			+++	+++		+	+++
Class Synurophyceae														
Mallomonas caudata Iwanoff [Ivanov]					+									
Mallomonas cf. *elegans* Lemmermann														
Mallomonas elongata Reverdin														
Mallomonas schwemmlei Glenk														
Mallomonas sp. Perty	++		++				+	+		+		+	+	+

Appendix Table B1. (cont.).

Taxon	B1 05.11. 2014	B1 25.02. 2015	B1 22.11. 2015	B1 15.03. 2017	B2 05.11. 2014	B2 25.02. 2015	B2 22.11. 2015	B3 05.11. 2014	B3 25.02. 2015	B3 22.11. 2015	B3 17.03. 2017	B5 05.11. 2014	B5 25.02. 2015	B5 22.11. 2015
Mallomonas cf. *majorensis* Skuja														
Microglena Ehrenberg														
Class Xanthophyceae Eustigmatophyceae														
Centritractus belonophorus (Schmidle) Lemmermann			+											++
Centritractus ellipsoideus Starmach	+	+												
Centritractus africanus F.E.Fritsch & M.F.Rich												+		
Ophiocytium capitatum Wolle			+											
Tetraëdriella regularis (Kützing) Fott					+									
Tetraëdriella polychloris Skuja														
Goniochloris Geitler			+											
Goniochloris fallax Fott				+										+
Goniochloris contorta (Bourrelly) H.Ettl														
Goniochloris smithii (Bourrelly) Fott												+		
Pseudostaurastrum lobulatum (Nägeli) Bourrelly														
Pseudostaurastrum hastatum (Reinsch) Chodat														

Appendix Table B1. (cont.).

Taxon	C1 06.11. 2014	C1 26.02. 2015	C1 22.11. 2015	C1 15.03. 2017	C2 06.11. 2014	C2 26.02. 2015	C2 22.11. 2015	C3 06.11. 2014	C3 26.02. 2015	C3 22.11. 2015	C3 15.03. 2017	C4 06.11. 2014	C4 26.02. 2015	C4 22.11. 2015	C5 06.11. 2014	C5 26.02. 2015	C5 22.11. 2015
Domain Eubacteria																	
Division Cyanobacteria (Cyanoprokaryota)																	
Anabaenopsis V.V.Miller																	
Aphanocapsa spp. C. Nägeli								+++	+++	+++	++	+++	+++	+++	+++	+++	+++
Aphanothece sp. C. Nägeli									+	+++			++	+++	+++	++	+
Chroococcus sp. Nägeli											+	+			++	++	+
Chroococcus limneticus Lemmerm.									+		+	+					+
Chroococcus minimus (Keissler) Lemmermann																	
Chrysosporum E.Zapomelová, O.Skaácelová, P.Pumann, R.Kopp & E.Janecek											+						
Cylindrospermopsis curvispora M.Watanabe										+							
Dolichospermum (Ralfs ex Bornet & Flahault) P.Wacklin, L.Hoffmann & J.Komárek								+		++							
Geitlerinema (Anagnostidis & Komárek) Anagnostidis						+											
Limnothrix redekei (Goor) Meffert												++					
Merismopedia punctata Meyen								+		++		+++		+++	++		
Merismopedia tenuissima Lemmermann	+				+			++		+++		+++	+	+++	+++		+++
Microcystis aeruginosa (Kützing) Kützing								+	++	++		++	+++		++	+++	
Microcystis firma (Kützing) Schmidle																	
Microcystis sp. (Kützing) Kützing														++			++
Microcystis viridis (A.Braun) Lemmermann																	
Oscillatoria Vaucher ex Gomont																	
unknown Oscillatoriales														++			
Phormidium sp. Kützing ex Gomont		+													+		
Planktolyngbya cf. brevicellularis G.Cronberg & Komárek								++				+++					
Planktolyngbya Anagnostidis & Komárek			+			+	+				+				++	++	
Planktothrix K.Anagnostidis & J.Komárek			++			+	+										
Planktothrix cryptovaginata (Schkorbatov) Anagnostidis & Komárek					+												
Planktothrix pseudaghardii Suda et al.				+													
Pseudanabaena sp. Lauterborn	+	+	+		+	+			+	+	+	+++	+++		+	+	+

Appendix Table B1. (cont.).

Taxon	C1 06.11. 2014	C1 26.02. 2015	C1 22.11. 2015	C1 15.03. 2017	C2 06.11. 2014	C2 26.02. 2015	C2 22.11. 2015	C3 06.11. 2014	C3 26.02. 2015	C3 22.11. 2015	C3 15.03. 2017	C4 06.11. 2014	C4 26.02. 2015	C4 22.11. 2015	C5 06.11. 2014	C5 26.02. 2015	C5 22.11. 2015
Pseudanabaena limnetica (Lemmermann) Komárek			+	+							++						
Rhabdoderma Schmidle & Lauterborn										++							
Romeria M.Koczwara														+			
Sphaerospermopsis (Forti) Zapomelová, Jezberová, Hrouzek, Hisem, Reháková & Komárková	+	+							+								++
Spirulina subsalsa Oersted ex Gomont																	
Synechococcus C.Nägeli	+	+		+	+								+				
Synechocystis C.Sauvageau																	
Domain Eukarya																	
Class Bacillariophyceae																	
Acanthoceras zachariasii (Brun) Simonsen																	
Achnanthes Bory	+++	++		+	+	+	++			+	+		+			+	
Amphora sp. Ehrenberg ex Kützing										+				+		+	
Amphora ovalis (Kützing) Kützing						+											
Amphora veneta Kützing													+				
Aulacoseira granulata (Ehrenberg) Simonsen								+		++				++			+
Aulacoseira granulata var. *angustissima* (Otto Müller) Simonsen										++	+						
Aulacoseira italica (Ehrenberg) Simonsen																	
Cocconeis sp. Ehrenberg	++	+			+		+	+			+	+	+++	+			
Cyclotella (Kützing) Brébisson					+			+	+	+++	++	+	++		+		+
Cymbella sp. C.Agardh	++	++	+	+	+		+						+				
Diatoma Bory																	
Epithemia Kützing						+			+		+			+			
Eunotia bilunaris (Ehrenberg) Schaarschmidt	+					+											
Eunotia sp. Ehrenberg	+		+	+			+										
Fragilaria capucina Desmazières																	
Fragilaria fasciculata (C.Agardh) Lange-Bertalot																	

Appendix Table B1. (cont.).

Taxon	C1 06.11. 2014	C1 26.02. 2015	C1 22.11. 2015	C1 15.03. 2017	C2 06.11. 2014	C2 26.02. 2015	C2 22.11. 2015	C3 06.11. 2014	C3 26.02. 2015	C3 22.11. 2015	C3 15.03. 2017	C4 06.11. 2014	C4 26.02. 2015	C4 22.11. 2015	C5 06.11. 2014	C5 26.02. 2015	C5 22.11. 2015
Fragilaria sp. Lyngbye									+	+				++			
Fragilaria ulna (Nitzsch) Lange-Bertalot		+++		++	+					+							+
Frustulia vulgaris (Thwaites) De Toni															+		
Gomphonema affine Kützing						+											
Gomphonema parvulum (Kützing) Kützing		+															
Gomphonema sp. Ehrenberg	++	++	+	++	+	++	+	+	++		+++	+	+++	+++	+	++	
Gomphonema truncatum Ehrenberg					+												
Gyrosigma Hassall				+		+											
Melosira varians C.Agardh				+													
Navicula Bory	+		++			+	+				+	+	+	+			
Navicula captoradiata																	
Navicula cryptocephala Kützing	+					+											
Neidium Pfitzer																	
Nitzschia acicularis										+							
Nitzschia constricta (Kützing) Ralfs			+														
Nitzschia palea (Kützing) W.Smith	+	+	++	+		+	+		+		+				+	++	
Nitzschia cf. *sigmoidea* (Nitzsch) W.Smith						+											
Nitzschia subacicularis Hustedt, nom. inval.					+												
Nitzschia Hassall					+			+		+							+
Pinnularia sp. Ehrenberg		++							+					+			
Rhopalodia Otto Müller						+							+				
Rhopalodia gibberula (Ehrenberg) Otto Müller													+				
Rhizosolenia longiseta O.Zacharias														+			
Surirella Ehrenberg									+								
Surirella cf. *elegans* Ehrenberg								+									
Surirella linearis W.Smith				+													
Tabellaria flocculosa (Roth) Kützing													++				

Appendix Table B1. (cont.).

Taxon	C1 06.11. 2014	C1 26.02. 2015	C1 22.11. 2015	C1 15.03. 2017	C2 06.11. 2014	C2 26.02. 2015	C2 22.11. 2015	C3 06.11. 2014	C3 26.02. 2015	C3 22.11. 2015	C3 15.03. 2017	C4 06.11. 2014	C4 26.02. 2015	C4 22.11. 2015	C5 06.11. 2014	C5 26.02. 2015	C5 22.11. 2015
Class Conjugatophyceae																	
Arthrodesmus Ehrenberg ex Ralfs																	
Closterium spp. Nitzsch ex Ralfs	+													+			
Cosmarium Corda ex Ralfs								++		+		+	+		+		+
Cosmarium garrolense J.Roy & Bisset		+															
Cosmarium hammeri var. *homalodermum* (Nordstedt) West & G.S.West		+															
Cosmarium *pachydermum* P.Lundell																	
Staurastrum cf. avicula Brébisson																	
Staurastrum spp. Meyen ex Ralfs										+		++		++	+		+
Class Chlorophyceae																	
Ankistrodesmus Chorda																	
Ankistrodesmus fusiformis Corda											+						
Carteria Diesing	+				+				+		++					+	
Chlamydomonas sp. Ehrenberg	+	+				+	+		++	++	+	+		++	+	+	+
Coelastrum astroideum De Notaris																	
Coelastrum microporum Nägeli																	
Coelastrum polychordum (Korshikov) Hindák																	
Coelastrum pseudomicroporum Korshikov																	
Coelastrum reticulatum (P.A.Dangeard) Senn										+			+				
Coenochloris hindakii Komárek										+	+						
Coenochloris Korshikov										+		+++		+	++		
Chlorolobion braunii (Nägeli) Komárek													+				
Desmatractum delicatissimum Korshikov												+	+				+
Desmodesmus quadricauda (Turpin) Brébisson																	
Eutetramorus Walton													+				

Appendix Table B1. (cont.).

Taxon	C1 06.11. 2014	C1 26.02. 2015	C1 22.11. 2015	C1 15.03. 2017	C2 06.11. 2014	C2 26.02. 2015	C2 22.11. 2015	C3 06.11. 2014	C3 26.02. 2015	C3 22.11. 2015	C3 15.03. 2017	C4 06.11. 2014	C4 26.02. 2015	C4 22.11. 2015	C5 06.11. 2014	C5 26.02. 2015	C5 22.11. 2015
Eutetramorus fottii (Hindák) Komárek												+					
Golenkinia brevispina Korshikov								+	+	+++		+					+
Golenkinia radiata Chodat												+++	++			++	+
Kirchneriella contorta (Schmidle) Bohlin														+			
Kirchneriella dianae (Bohlin) Comas Gonzalez										+		+		++			
Kirchneriella lunaris (Kirchner) Möbius																	
Kirchneriella microscopica Nygaard																	
Kirchneriella obesa (West) West & G.S.West																	
Kirchneriella sinensis Skvortzov																	
Kirchneriella subcapitata Korshikov																	
Kirchneriella Schmidle																	
Monoraphidium circinale (Nygaard) Nygaard						+			+	+++	++		+++	+++	+++	+++	+++
Monoraphidium contortum (Thuret) Komárková-Legnerová								++		+				+			
Monoraphidium convolutum (Corda) Komárková-Legnerová																	
Monoraphidium komarkovae Nygaard																	+
Monoraphidium minutum (Nägeli) Komárková-Legnerová		+		+					++	++		++	+	+++		+	
Monoraphidium Komárková-Legnerová			+							++	+	++			+		
Pediastrum duplex Meyen																	
Pediastrum simplex Meyen			+							+			+	+	+	++	+
Pediastrum simplex var. *echinulatum* Wittrock										+							
Pediastrum tetras (Ehrenberg) Ralfs													+				
Quadrigula lacustris (Chodat) G.M.Smith												+					
Scenedesmus Meyen									+			++			++		++
Scenedesmus acutus Meyen																	
Scenedesmus bicaudatus Dedusenko				+													
Scenedesmus ecornis (Ehrenberg) Chodat								+	+	+			+	+		++	
Scenedesmus linearis Komárek											+	+					
Scenedesmus dimorphus (Turpin) Kützing																	
Scenedesmus disciformis (Chodat) Fott & Komárek														+	+		

Appendix Table B1. (cont.).

Taxon	C1 06.11. 2014	C1 26.02. 2015	C1 22.11. 2015	C1 15.03. 2017	C2 06.11. 2014	C2 26.02. 2015	C2 22.11. 2015	C3 06.11. 2014	C3 26.02. 2015	C3 22.11. 2015	C3 15.03. 2017	C4 06.11. 2014	C4 26.02. 2015	C4 22.11. 2015	C5 06.11. 2014	C5 26.02. 2015	C5 22.11. 2015
Scenedesmus intermedius Chodat												+					
Scenedesmus obtusus Meyen															+		
Scenedesmus pecsensis Uherkovich																	
Scenedesmus sempervirens Chodat																	
Scenedesmus spinosus Chodat																	
Scenedesmus verrucosus Y.V.Roll								+									
Schroederia planctonica (Skuja) Philipose																	
Sorastrum Kützing																	
Spermatozopsis exultans Korshikov				+++						++							
Tetraedron caudatum (Corda) Hansgirg									+	++	+	++	+	+	++	++	++
Tetraëdron incus (Teiling) G.M.Smith												+		+			
Tetraëdron mediocris Hindák																	
Tetraedron minimum (A.Braun) Hansgirg								+	+	++		+	+	++	+		+
Tetrastrum heteracanthum (Nordstedt) Chodat												+					
Tetrastrum komarekii Hindák				+					+	++		++	++	++	+	+	
Tetrastrum punctatum (Schmidle) Ahlstrom & Tiffany																	
Tetrastrum triacanthum Korshikov															+		
Tetrastrum triangulare (Chodat) Komárek								+									
Treubaria triappendiculata C.Bernard										+				+			+
Westella botryoides (West) De Wildeman																	
Willea rectangularis (A.Braun) D.M.John, M.J.Wynne & P.M.Tsarenko												+	+				
Willea vilhelmii (Fott) Komárek										+			+		+		
unknown Chlorophyceae	+				+							+		++	+		

Appendix Table B1. (cont.).

Taxon	C1 06.11. 2014	C1 26.02. 2015	C1 22.11. 2015	C1 15.03. 2017	C2 06.11. 2014	C2 26.02. 2015	C2 22.11. 2015	C3 06.11. 2014	C3 26.02. 2015	C3 22.11. 2015	C3 15.03. 2017	C4 06.11. 2014	C4 26.02. 2015	C4 22.11. 2015	C5 06.11. 2014	C5 26.02. 2015	C5 22.11. 2015
Class Trebouxiophyceae																	
Actinastrum gracillimum G.M.Smith								+++									
Actinastrum hantzschii Lagerheim				+						+	+				+		
Botryococcus terribilis Komárek & Marvan																	
Closteriopsis acicularis (Chodat) J.H.Belcher & Swale															+		
Crucigenia tetrapedia (Kirchner) Kuntze								+		+		+++			+		
Crucigeniella apiculata (Lemmermann) Komárek # CRUL API																	
Crucigeniella pulchra (West & G.S.West) Komárek								+									
Crucigeniella crucifera (Wolle) Komárek										++				+			+
Crucigeniella rectangularis (Nägeli) Komárek															+		
Dichotomococcus Korshikov, 1928																	
Dictyosphaerium ehrenbergianum Nägeli																	
Dictyosphaerium subsolitarium Van Goor												+					
Dictyosphaerium Nägeli												+					
Franceia elongata Korshikov																	
Franceia javanica (C.Bernard) Hortobágyi																	
Golenkiniopsis longispina (Korshikov) Korshikov																	
Golenkiniopsis solitaria (Korshikov) Korshikov														+			
Golenkiniopsis parvula (Woronichin) Korshikov								+		++					+		
Lagerheimia chodatii C.Bernard								+				+					
Lagerheimia ciliata (Lagerheim) Chodat													+				
Lagerheimia cingula G.M.Smith													+				
Lagerheimia genevensis (Chodat) Chodat											+		+	++		+	
Lagerheimia quadriseta (Lemmermann) G.M.Smith																	+
Lagerheimia subsalsa Lemmermann						+		+	+	+			++	++	++	++	
Micractinium pusillum Fresenius																	
Nephrocytium agardhianum Nägeli										+	+						
Nephrocytium limneticum (G.M.Smith) G.M.Smith																	
Nephrocytium schilleri (Kammerer) Comas González																	

Appendix Table B1. (cont.).

Taxon	C1 06.11. 2014	C1 26.02. 2015	C1 22.11. 2015	C1 15.03. 2017	C2 06.11. 2014	C2 26.02. 2015	C2 22.11. 2015	C3 06.11. 2014	C3 26.02. 2015	C3 22.11. 2015	C3 15.03. 2017	C4 06.11. 2014	C4 26.02. 2015	C4 22.11. 2015	C5 06.11. 2014	C5 26.02. 2015	C5 22.11. 2015
Nephrocytium Nägeli										+							
Oocystis sp Nägeli ex A.Braun								+	++	+++		+++	++	+		++	+
Oocystis nephrocytioides Fott & Cado												+					
Planctonema lauterbornii Schmidle										++				++			+++
Tetrachlorella Korshikov, 1939																	
Tetrachlorella alternans (G.M.Smith) Korshikov								+						+			
Class Euglenophyceae																	
Euglena acus (O.F.Müller) Ehrenberg		+		+													
Euglena cf. *viridis* (O.F.Müller) Ehrenberg													+				
Euglena spp. Ehrenberg	+++	+	++	+++	+++	+	+	+		+	++			++	++		+
Lepocinclis capito Wehrle																	
Lepocinclis constricta Matvienko										+							
Lepocinclis elongata (Swirenko) Conrad																	
Lepocinclis cf. *ovum* (Ehrenberg) Lemmermann			+	+			+				+			+			
Lepocinclis texta (Dujardin) Lemmermann					+										+		
Lepocinclis truncata A.M.Cunha																	
Lepocinclis Perty									+				+				
Notosolenus A.C.Stokes																	
Phacus acuminatus Stokes																	
Phacus helikoides Pochmann																	
Phacus cf *lismorensis*													+				
Phacus longicauda (Ehrenberg) Dujardin										+		+		+	+		
Phacus tortus (Lemmermann) Skvortzov																	
Phacus sp. Dujardin	+			+						+		+			++	+	
Strombomonas verrucosa (E.Daday) Deflandre				+	+												
Trachelomonas Ehrenberg		+			+	+	+			+							
Trachelomonas sydneyensis Playfair					+												

Appendix Table B1. (cont.).

Taxon	C1 06.11. 2014	C1 26.02. 2015	C1 22.11. 2015	C1 15.03. 2017	C2 06.11. 2014	C2 26.02. 2015	C2 22.11. 2015	C3 06.11. 2014	C3 26.02. 2015	C3 22.11. 2015	C3 15.03. 2017	C4 06.11. 2014	C4 26.02. 2015	C4 22.11. 2015	C5 06.11. 2014	C5 26.02. 2015	C5 22.11. 2015
Trachelomonas subdenticulata (Playfair) W.Conrad					+												
Trachelomonas superba Svirenko					+												
Trachelomonas volvocina (Ehrenberg) Ehrenberg					+							+		+			+
Trachelomonas volvocinopsis Svirenko													+				
Class Klebsormidiophyceae																	
Elakatothrix viridis (J.W.Snow) Printz														+			
Class Cryptophceae																	
Cryptomonas Ehrenb.	+++	++	++	+++	+++	+++	+++	++	+++	+++	+++	+++	+++	+++	+++	+++	+++
Class Dinophyceae																	
Ceratium hirundinella (O.F.Müller) Dujardin									+			+++		++	+		+
Glenodinium Ehrenberg		++															
Gymnodinium F.Stein	+				++			+		+	++	+			+	+++	
Gymnodinium simplex (Lohmann) Kofoid & Swezy										+							
Gymnodinium uberrimum (G.J.Allman) Kofoid & Swezy																	
Peridiniopsis Lemmermann										++							
Peridinium Ehrenberg		++			+		+	+	++		++		++	+++	+		
Peridinium brevipes Paulsen	+++									+		+					
Peridinium bipes Stein	+			+												++	+
Peridinium willei Huitfeldt-Kaas																	
Class Chrysophyceae																	
Bitrichia chodatii (Reverdin) Chodat																	
Bitrichia cf. *phaseolus* (Fott) Bourr.																	
unknown Chrysophceae			++			+	+										+++
Chromulina L.Cienkowsky	+	++	+		++		+		++	++	+++	+	+++	+++	++	+++	
Chrysidiastrum catenatum Lauterborn																	

Appendix Table B1. (cont.).

Taxon	C1 06.11. 2014	C1 26.02. 2015	C1 22.11. 2015	C1 15.03. 2017	C2 06.11. 2014	C2 26.02. 2015	C2 22.11. 2015	C3 06.11. 2014	C3 26.02. 2015	C3 22.11. 2015	C3 15.03. 2017	C4 06.11. 2014	C4 26.02. 2015	C4 22.11. 2015	C5 06.11. 2014	C5 26.02. 2015	C5 22.11. 2015
Chrysococcus G.A.Klebs					+			+++		++		+	+			+	
Dinobryon bavaricum Imhof										+		+		++		+	+
Dinobryon crenulatum West & G.S.West								+				+	+		+		+
Dinobryon divergens O.E.Imhof											+					+	+
Dinobryon divergens var. *schauinslandii* (Lemmermann) Brunnthaler												+	+				
Dinobryon sociale (Ehrenberg) Ehrenberg								+							+		
Dinobryon sertularia Ehrenberg									+	+	+		+	+++		+	+
Dinobryon stokesii Lemmermann																++	
Dinobryon suecicum Lemmermann																	
Epipyxis lauterbornii (Lemmermann) D.K.Hilliard & Asmund																	
Ochromonas Vysotskij sp.	+	+	+	++		+	+	+++	+	++	++	+++	+++	+	+	+++	++
Ochromonas polychrysis Skuja																	+
Ochromonas reptans Conrad																+	
Kephyrion Pascher												++					
Pseudokephyrion Pascher																	
Stokesiella acuminata (A.Stokes) Lemmermann	+																
Class Bicosoecaceae																	
Bicosoeca eurystoma Hilliard																	
Class Prymnesiophyceae (Haptophyceae)																	
Chrysochromulina parva Lackey	+			+						+++	++		++		+	+++	
Class Synurophyceae																	
Mallomonas caudata Iwanoff [Ivanov]					+							+	+		+		+
Mallomonas cf. *elegans* Lemmermann # MALLOMZZ																	
Mallomonas elongata Reverdin																	
Mallomonas schwemmlei Glenk										+							
Mallomonas sp. Perty	+			+	+			+	+	+	+		+		+		
Mallomonas cf. *majorensis* Skuja																	

Appendix Table B1. (cont.).

Taxon	C1 06.11. 2014	C1 26.02. 2015	C1 22.11. 2015	C1 15.03. 2017	C2 06.1.1 2014	C2 26.02. 2015	C2 22.11. 2015	C3 06.11. 2014	C3 26.02. 2015	C3 22.11. 2015	C3 15.03. 2017	C4 06.11. 2014	C4 26.02. 2015	C4 22.11. 2015	C5 06.11. 2014	C5 26.02. 2015	C5 22.11. 2015
Microglena Ehrenberg												+					
Class Xanthophyceae																	
Centritractus belonophorus (Schmidle) Lemmermann								+		+				+		+	+
Centritractus ellipsoideus Starmach											+						
Centritractus africanus F.E.Fritsch & M.F.Rich																	
Ophiocytium capitatum Wolle										+							
Tetraëdriella regularis (Kützing) Fott																+	
Tetraëdriella polychloris Skuja													+				
Goniochloris Geitler																	
Goniochloris fallax Fott															+	+	+
Goniochloris contorta (Bourrelly) H.Ettl													+				
Goniochloris smithii (Bourrelly) Fott																	
Pseudostaurastrum lobulatum (Nägeli) Bourrelly																	
Pseudostaurastrum hastatum (Reinsch) Chodat												+					

Appendix Table B2. Aquatic macrophytes in Inlay Lake in November 2014, February and November 2015, and March 2017. Abundance score; based on a semi-quantitative scale, where 1 = rare, 2 = scattered, 3 = common, 4 = locally dominant and 5 = dominant. -1: occurrence (no score), +: drifting specimen

Localities in transect A:	**A1**	**A1**	**A1**	**A1**	**A2**	**A2**	**A2**	**A3**	**A3**	**A3**	**A3**	**A4**	**A4**	**A4**	**A5**	**A5**	**A5**
Latin names	nov.14	feb.15	nov.15	mar.17	nov.14	feb.15	nov.15	nov.14	feb.15	nov.15	mar.17	nov.14	feb.15	nov.15	nov.14	feb.15	nov.15
ELODEIDS																	
Ceratophyllum demersum	2		2	4										1	4	3	4
Hydrilla verticillata																	
Myriophyllum cf spicatum	2		-1														
Myriophyllum verticillatum	5	5	5	5		2					2						2
Najas indica	2	4	4		2	3											
Nechamandra alternifolia	2	3	1			3	2	5	5	5	4	5	3-4	5	3	2-3	3
Potamogeton crispus	2														1		
Potamogeton lucens	2	1	2		5	5	4	2			3	+	3-4	5	2	2	2
Potamogeton lucens-hybrid													-1				
Potamogeton cf nodosus																	
Potamogeton cf wrightii						-1											
Stuckenia pectinata																	
Stuckenia pectinata-hybrid																	
Utricularis cf aurea			1			1										-1	
Utricularia cf australis	2														2	-1	
NYMPHAEIDS																	
Nelumbo nucifera															+		
Nymphaea nouchali																	
Nymphaea pubescens																	
Nymphaea sp																	
Nymphoides cf hydrophylla																	
Nymphoides indica																	
Ottelia alismoides				2	2		2								1		
LEMNIDS																	
Eichornia crassipes	3	3	2	3				5	5	5	2	3	2	5	4	4	3
Lemna trisulca								1									
Pistia stratiotes								1-2						2	1		1
Spirodela polyrhizza								1							1		
Salvinia cucullata	2		1	2				3		2	1			2	1		1
CHAROPHYTES																	
Chara cf. zeylanica						4-5	5	3	4-5	5	5		3-4				
total number of species	**10**	**5**	**9**	**5**	**3**	**7**	**4**	**8**	**3**	**4**	**6**	**3**	**5**	**6**	**11**	**6**	**7**

Appendix Table B2. (cont.)

Localities in transect B: **Latin names**	**B1** nov.14	**B1** feb.15	**B1** nov.15	**B1** mar.17	**B2** nov.14	**B2** feb.15	**B2** nov.15	**B3** nov.14	**B3** feb.15	**B3** nov.15	**B3** mar.17	**B5** nov.14	**B5** feb.15	**B5** nov.15
ELODEIDS														
Ceratophyllum demersum	4-5	3	4	3-4	2							2		3
Hydrilla verticillata												1		
Myriophyllum cf spicatum														
Myriophyllum verticillatum				2								3	+	1
Najas indica								-1						
Nechamandra alternifolia	2	1	+	2				+	3		2	2	+	1
Potamogeton crispus														
Potamogeton lucens	2-3		2	1	2	4		-1	4-5	4-5	2	3	4	4
Potamogeton lucens-hybrid													-1	
Potamogeton cf nodosus		1-2												
Potamogeton cf wrightii			+											
Stuckenia pectinata														
Stuckenia pectinata-hybrid														
Utricularis cf aurea		1		1			+							
Utricularia cf australis	2				1							2		
NYMPHAEIDS														
Nelumbo nucifera														
Nymphaea nouchali														
Nymphaea pubescens														
Nymphaea sp														
Nymphoides cf hydrophylla														
Nymphoides indica														
Ottelia alismoides														
LEMNIDS														
Eichornia crassipes	5	4-5	5	2-3	4	2		4	2		2	5	2	4
Lemna trisulca														
Pistia stratiotes	2		3					+						
Spirodela polyrhizza			1											
Salvinia cucullata	2	1	1					+				2		1
CHAROPHYTES														
Chara cf. zeylanica					2	-1		-1	5	2-3	3			
total number of species	**7**	**6**	**8**	**6**	**5**	**3**	**1**	**7**	**4**	**2**	**4**	**8**	**5**	**6**

Appendix Table B2. (cont.)

Localities in transect D&E:	**C1**	**C1**	**C1**	**C1**	**C2**	**C2**	**C2**	**C3**	**C3**	**C3**	**C3**	**C4**	**C4**	**C4**	**C5**	**C5**	**C5**
Latin names	nov.14	feb.15	nov.15	mar.17	nov.14	feb.15	nov.15	nov.14	feb.15	nov.15	mar.17	nov.14	feb.15	nov.15	nov.14	feb.15	nov.15
ELODEIDS																	
Ceratophyllum demersum	2	2						-1	4	3	3	4	2		2		2
Hydrilla verticillata	4	4			1				4		2	1					
Myriophyllum cf spicatum																	
Myriophyllum verticillatum	3	1			+	2	5				3					3	1
Najas indica	5	5							5		-1	1		2	1		5
Nechamandra alternifolia	1			+				-1		1	4					3	1
Potamogeton crispus		4		+		3			2		2					1	
Potamogeton lucens	3	4						-1		4	5	3	5	3	+	1	
Potamogeton lucens-hybrid		3												-1			
Potamogeton cf nodosus	2					3			3	5				5	1		
Potamogeton cf wrightii		-1									2						
Stuckenia pectinata									5		2	2	3	2			1
Stuckenia pectinata-hybrid									-1		1			1			
Utricularis cf aurea	1								3			1	3			1	2
Utricularia cf australis												2	-1		1		
NYMPHAEIDS																	
Nelumbo nucifera					2	3	4										
Nymphaea nouchali																	
Nymphaea pubescens			2	1	3		3										
Nymphaea sp																	
Nymphoides cf hydrophylla						2											
Nymphoides indica																	
Ottelia alismoides	2			1	1	3	2			2							
LEMNIDS																	
Eichornia crassipes	3	4	4	4	2	4	4	-1	1		4				3-4	3-4	5
Lemna trisulca																	
Pistia stratiotes								-1							1		
Spirodela polyrhizza	1																
Salvinia cucullata	2						2	-1			2				3	2	
CHAROPHYTES																	
Chara cf. zeylanica													4	3			
total number of species	**12**	**9**	**2**	**5**	**6**	**7**	**6**	**6**	**9**	**5**	**12**	**7**	**6**	**7**	**8**	**7**	**7**

Appendix Table B2. (cont.)

Localities in transect D&E:	**D**	**D**	**E2**	**E1**	**E1**
Latin names	nov.14	feb.15	nov.14	feb.15	nov.15
ELODEIDS					
Ceratophyllum demersum					
Hydrilla verticillata	-1				
Myriophyllum cf spicatum			4	3	
Myriophyllum verticillatum					4
Najas indica					
Nechamandra alternifolia	-1	+	2		+
Potamogeton crispus					
Potamogeton lucens	-1				
Potamogeton lucens-hybrid					
Potamogeton cf nodosus					
Potamogeton cf wrightii					
Stuckenia pectinata					
Stuckenia pectinata-hybrid					
Utricularis cf aurea					
Utricularia cf australis	-1	+	4		
NYMPHAEIDS					
Nelumbo nucifera				5	5
Nymphaea nouchali					1
Nymphaea pubescens					2
Nymphaea sp	-1	1			
Nymphoides cf hydrophylla					
Nymphoides indica			4	1-2	2
Ottelia alismoides	-1	2			2
LEMNIDS					
Eichornia crassipes	-1	4		2	3
Lemna trisulca					
Pistia stratiotes	-1	2			
Spirodela polyrhizza					
Salvinia cucullata	-1	2		1	2-3
CHAROPHYTES					
Chara cf. zeylanica					
total number of species	**9**	**7**	**4**	**5**	**9**

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