Adelaide Desalination Plant Plankton Monitoring Program

March 2014 report

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This report provides data from samples collected on the 13th of March 2014 from the intake tunnel of the Adelaide Desalination Plant (ADP) prior to the band screens. Samples were collected for the analysis of phyto-, zoo-, and ichthyoplankton biomass and abundance using the methods outlined in appendix 1. This report also includes data from offshore sampling conducted to provide an indication of natural environmental conditions offshore from the ADP for comparison with data from in-plant samples. Offshore sampling was also conducted on the 13th of March 2014, with methods outlined in appendix 2.

Water samples for the analysis of pigment composition were filtered through stacked mesh (to retain cells >5 µm) and Whatman GF/F filters (nominal pore size 0.4 µm, to retain cells <5 µm), allowing the examination of size fractionated phytoplankton biomass. Filters were frozen and stored at -80°C prior to analysis via the gradient elution procedure of (Van Heukelem and Thomas 2001) on an Algilent 1200 series High Pressure Liquid Chromatography (HPLC) system in the environmental chemistry laboratory at SARDI Aquatic Sciences. Enumeration and identification of phytoplankton to genus or species level was carried out by Microalgal Services, Victoria, Australia, using traditional taxonomic methods.

Zooplankton samples were rinsed through a 35 µm mesh sieve to remove all traces of preservative. The contents of the sieve were rinsed into 100 ml measuring cylinders and allowed to settle for 24 hours, after which settling volumes (biomass) were recorded. Samples were then decanted into 120 ml jars and resuspended in 100 ml of water (i.e. concentrated 10x). Samples were viewed, identified and enumerated with a compound microscope. Counts were continued until 100 specimens of the dominant taxa were counted. Organism numbers were recorded as individuals m^{-3} in the water column using the volume swept by the net, calculated as the distance travelled by the net (recorded by a flow meter suspended in the mouth of the net) multiplied by the area of the net mouth. Settling volumes were recorded as ml m^{-3} using the volume swept.

Ichthyoplankton samples were pooled during rinsing through a 35 µm mesh sieve to remove all traces of preservative. The entire sample was sorted under a dissecting microscope at up to 60x magnification. Egg and larval numbers m^{-3} were recorded using the volume swept by the net, calculated as the distance travelled by the net (recorded by a flow meter suspended in the mouth of the net) multiplied by the area of the net mouth.

Phytoplankton biomass, abundance, and community composition

Mean chlorophyll *a* (chl *a*) concentrations in the plant in March were ~twice the concentrations in February. Total chl *a* was 0.1 (±0.001) µg L^{-1}, with most of the biomass in the small size fraction (cells <5 µm in diameter, figure 1). This is ~1/2-1/3 the values previously reported for March in waters off Port Stanvac (van Ruth 2010, 2012). Analysis of marker pigments normalised to chl *a* indicate that the small size fraction of phytoplankton biomass was dominated by chrysophytes with small flagellates (haptophytes, chlorophytes, euglenophytes, prasinophytes) and cyanobacteria also present (figure 2). There was a decrease in the presence of chrysophytes from February to March. The large size fraction of phytoplankton biomass was dominated by diatoms (figure 3).

Offshore total chl *a* was 0.2 (±0.01) µg L^{-1}, with most of the biomass in the small size fraction (figure 1), typical results for Port Stanvac in March (van Ruth 2010, 2012). Analysis of normalised marker pigments in offshore samples revealed similar results to in-plant samples, though haptophytes were more dominant than chrysophytes (figure 2). Similarly to in-plant samples, diatoms dominated the large size fraction of offshore samples. In contrast to the previous month peridinin was detected, indicating the presence of dinoflagellates in the community (figure 3).

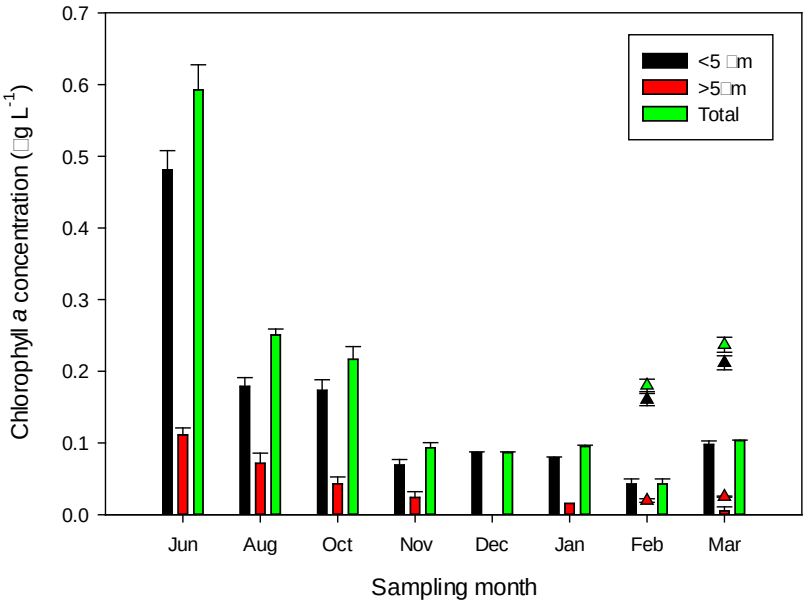

Figure 1. Mean total chlorophyll *a* concentrations, and concentrations in the small (<5 µm) and large (>5 µm) size fractions of phytoplankton biomass in samples collected from the intake tunnel of the Adelaide Desalination Plant (ADP) prior to the band screens (bars), and offshore at the intake riser pipe (triangles) in 2013/2014. Error bars indicate standard error.

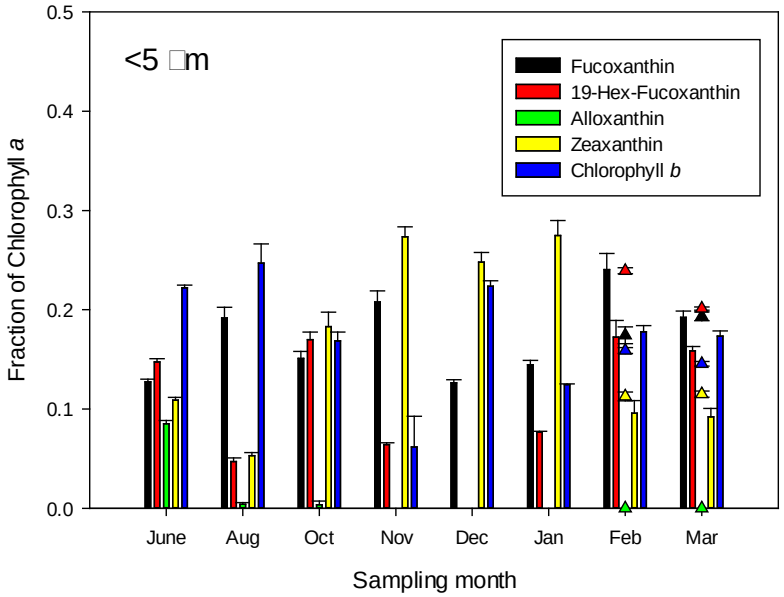

Figure 2. Mean concentrations of selected marker pigments normalised to total chlorophyll *a* (weight:weight) in the small size fraction of phytoplankton biomass (<5 µm) in samples collected from the intake tunnel of the Adelaide Desalination Plant (ADP) prior to the band screens (bars), and offshore at the intake riser pipe (triangles) in 2013/2014. Error bars indicate standard error. Fucoxanthin is an indicator of chrysophytes, 19-hexanoyloxyfucoxanthin is an indicator of haptophytes, alloxanthin is an indicator of cryptophytes, zeaxanthin is an indicator of cyanobacteria, and chlorophyll *b* is an indicator of chlorophytes, euglenophytes and prasinophytes.

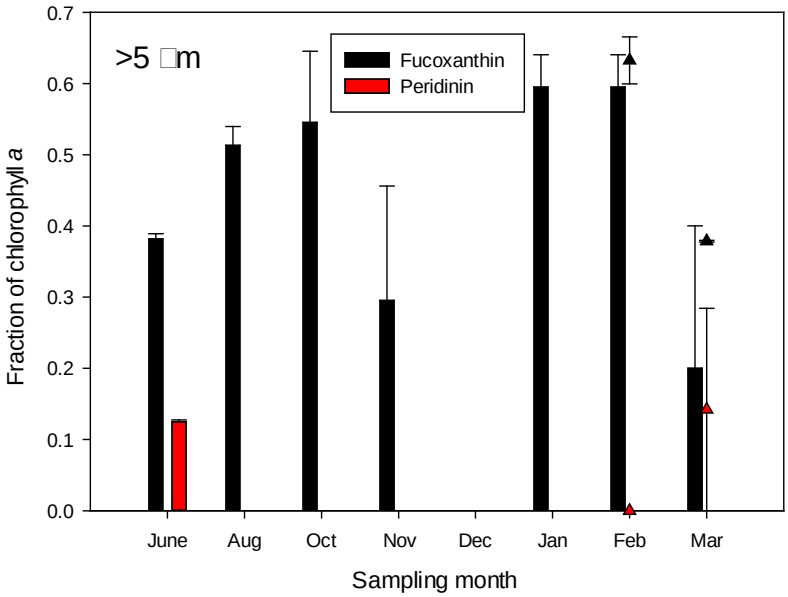

Figure 3. Mean concentrations of selected marker pigments normalised to total chlorophyll *a* (weight:weight) in the large size fraction of phytoplankton biomass (>5 µm) in samples collected from the intake tunnel of the Adelaide Desalination Plant (ADP) prior to the band screens (bars), and offshore at the intake riser pipe (triangles) in 2013/2014. Error bars indicate standard error. Fucoxanthin is an indicator of diatoms, peridinin is an indicator of dinoflagellates.

In-plant mean total phytoplankton abundance was 70,358 (±26,198) cells L^{-1}, and was dominated by small flagellates (figure 4), in particular the cyanobacteria *Phormidium* sp. (14,067 ± 9,973 cells L^{-1}), and *Pseudoanabaena* sp. (10,625 ± 8,471 cells L^{-1}). Unidentified ochrophytes were also present in relatively high abundances (7,600 ± 2,088 cells L^{-1}). Diatoms were dominated by *Ceratoneis closterium* (15,000 ± 2,517 cells L^{-1}), and Dinoflagellates were dominated by *Gymnodinium* spp. (8,200 ± 1,943 cells L^{-1}). There were several other species of dinoflagellates present in abundances <1,000 cells L^{-1} which explains the peridinin signature observed in pigment samples.

Mean total phytoplankton abundance in offshore samples was 70,692 (±19,009) cells L^{-1}, similar to in-plant abundance (figure 4). Diatoms dominated the community, with *Ceratoneis closterium* (27,000 ± 8,622 cells L^{-1}), particularly abundant. The offshore dinoflagellate community was also dominated by *Gymnodinium* spp. (9,100 ± 2,551 cells L^{-1}), with the presence of several other species of dinoflagellates in abundances <1,000 cells L^{-1} explaining the peridinin signature observed in pigment samples, similar to those collected in-plant. Unidentified ochrophytes (8,933 ± 1,312 cells L^{-1}) were the most abundant small flagellates in offshore samples. The cyanobacteria *Phormidium* sp. and *Pseudoanabaena* sp. were not detected in offshore samples.

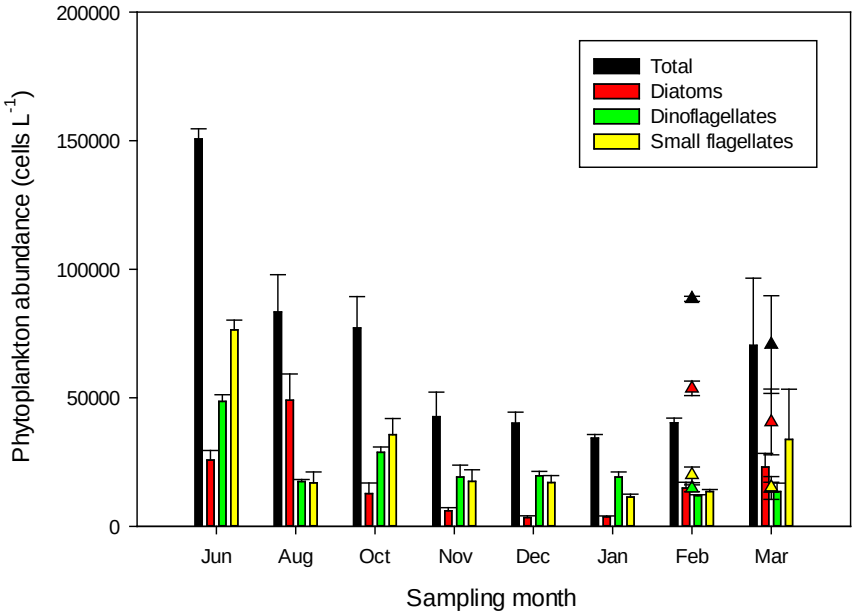

Figure 4. Mean phytoplankton abundance in samples collected from the intake tunnel of the Adelaide Desalination Plant (ADP) prior to the band screens (bars), and offshore at the intake riser pipe (triangles) in 2013/2014. Error bars indicate standard error.

Zooplankton biomass, abundance, and community composition

Mean in-plant zooplankton biomass was 0.8 (±0.1) ml m^{-3} (figure 5), ~1/3 the biomass reported for February, and similar to the biomass previously reported for Port Stanvac in March (van Ruth 2010, 2012). Mean abundance was 4,530 (±535) individuals m^{-3} (figure 6), an order of magnitude lower than previously reported for Port Stanvac in March (van Ruth 2010, 2012). The zooplankton community was dominated by copepod nauplii, with copepods and mussel larvae also relatively abundant.

In offshore samples, mean zooplankton biomass was 6.5 (±0.8) ml m^{-3} (figure 5), which is an order of magnitude > values previously reported for the area in March (van Ruth 2010, 2012). Mean abundance in offshore samples was 223,376 (±19,337), ~4 times the abundance previously reported for Port Stanvac (van Ruth 2010, 2012), with the community dominated by copepod nauplii, copepods and mussel larvae, similar to in-plant samples, with gastropod larvae, appendicularia and cladocera also relatively abundant.

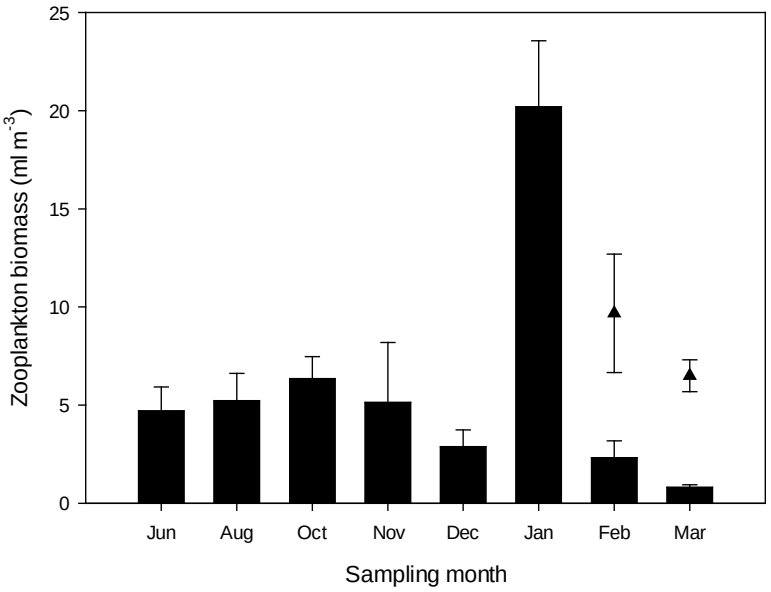

Figure 5. Mean zooplankton biomass in samples collected from the intake tunnel of the Adelaide Desalination Plant (ADP) prior to the band screens (bars), and offshore at the intake riser pipe (triangles) in 2013/2014. Error bars indicate standard error.

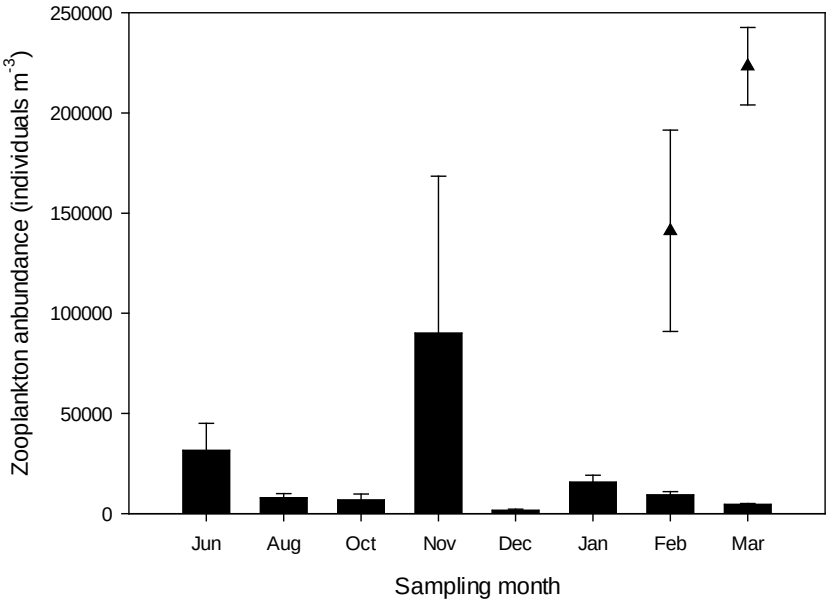

Figure 6. Mean zooplankton abundance in samples collected from the intake tunnel of the Adelaide Desalination Plant (ADP) prior to the band screens (bars), and offshore at the intake riser pipe (triangles) in 2013/2014. Error bars indicate standard error.

Ichthyoplankton biomass, abundance, and community composition

In contrast to previous months sampling, sardine (*Sardinops sagax)* eggs were detected in in-plant samples collected in March 2014 (1.7 eggs m^{-3}, figure 7). There were no fish larvae found in in-plant samples in March (figure 8). Sardine eggs were also present in offshore samples at concentrations of 0.5 eggs m^{-3} (figure 7), similar to abundances previously reported for Port Stanvac (van Ruth 2010, 2012). Fish larvae were also identified in offshore samples, in concentrations of 0.4 larvae m^{-3} (figure 8), ~double abundances previously reported for Port Stanvac (van Ruth 2010, 2012). Larvae found during March 2014 were not able to be identified.

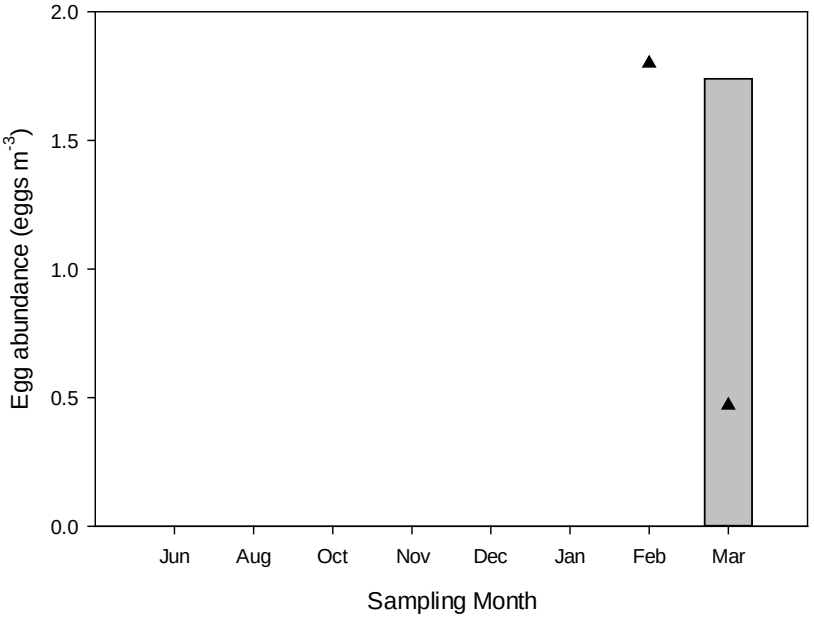

Figure 7. Fish egg abundance in samples collected from the intake tunnel of the Adelaide Desalination Plant (ADP) prior to the band screens (bars), and offshore at the intake riser pipe (triangles) in 2013/2014.

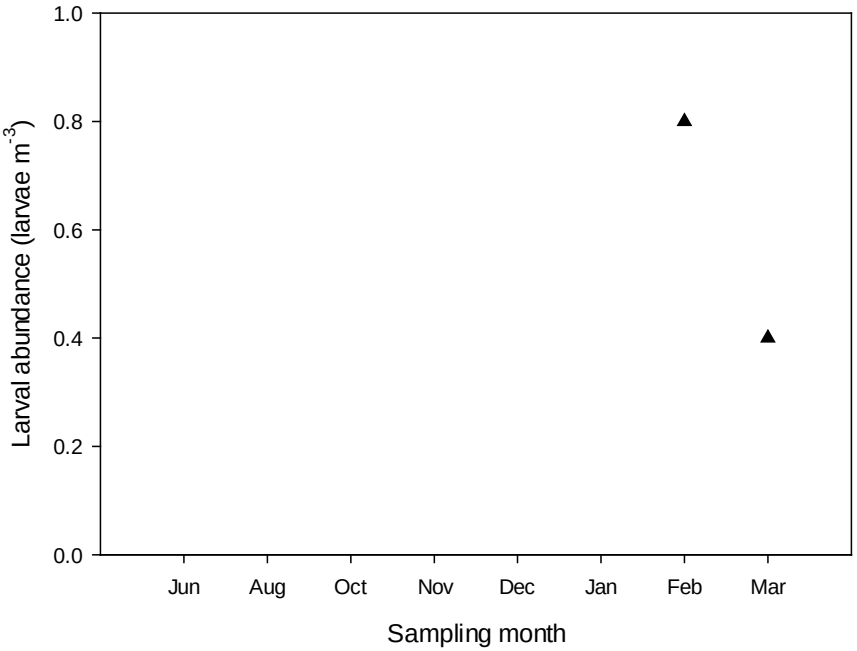

Figure 8. Fish larval abundance in samples collected from the intake tunnel of the Adelaide Desalination Plant (ADP) prior to the band screens (bars), and offshore at the intake riser pipe (triangles) in 2013/2014.

References

Van Heukelem, L. and Thomas, C. S. (2001). Computer-assisted high-performance liquid chromatography method development with applications to the isolation and analysis of phytoplankton pigments. Journal of Chromatography A, 910: 31 – 49.

van Ruth, P.D. (2012) Adelaide Desalination Project Plankton Characterisation Study – Phase 2. Prepared for Adelaide Aqua. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000378-2. SARDI Research Report Series No. 606. 40pp.

van Ruth, P. D. (2010) Adelaide desalination project plankton characterisation study, prepared for Adelaide Aqua. SARDI Publication. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000378-1. SARDI Research Report Series No. 487. 39 pp.

Appendix 1

Adelaide Desalination Project Plankton Monitoring Program

Revised sampling protocol

1). Phytoplankton biomass, abundance and community composition:

- Samples to be collected from surface waters with a weighted bucket.

  Pigments (biomass)

  - 3 x independent **2 L** samples collected
  - Fill jars to the 2 L line
  - Samples to be stored in the dark immediately after collection

  Abundance and community composition

  - 3 x independent **1 L** samples collected
  - Fill jars to the 1 L line
  - Samples to be preserved with 2 ml Lugol's iodine solution

2). Zooplankton biomass, abundance and community composition

- 3 x independent samples collected by lowering a weighted 20 µm mesh net below the water surface, with the net mouth open to the flow for 1 minute
  - Record flow meter reading prior to deployment of net
  - Lower net to collect sample
  - Record flow meter reading after sampling
  - Wash net down to rinse entire contents into the cod-end
  - Rinse contents of cod-end into a 1 L jar, top up with water
- Samples to be preserved with 50 ml of formalin

3). Ichthyoplankton biomass, abundance and community composition

- 5 x independent samples collected by lowering a weighted 350 µm mesh net below the water surface, with the net mouth open to the flow for 1 minute
  - Record flow meter readings prior to deployment of net
    - **Note:** Net 1 has green and yellow striped tape on the frame
  - Lower net to collect sample
  - Record flow meter readings after sampling
  - Wash both nets down to rinse entire contents into the cod-ends
  - Rinse contents of both cod-ends into a 1 L jar, top up with water
- Samples to be preserved with 50 ml of formalin

Appendix 2

Adelaide Desalination Project Plankton Monitoring Program

Offshore sampling protocol

Samples collected on the same day as in-plant sampling, above the intake riser pipe, offshore from the Adelaide Desalination Plant, 138.4679 ° E, 35.09059° S.

1). Phytoplankton biomass, abundance and community composition:

- Samples to be collected from surface waters with a weighted bucket.

  Pigments (biomass)

  - 3 x independent **2 L** samples collected
  - Fill jars to the 2 L line
  - Samples to be stored in the dark immediately after collection

  Abundance and community composition

  - 3 x independent **1 L** samples collected
  - Fill jars to the 1 L line
  - Samples to be preserved with 2 ml Lugol's iodine solution

2). Zooplankton biomass, abundance and community composition

- 3 x independent samples collected by lowering a weighted 20 µm mesh net to within 1 m of the sea floor and retrieving vertically
  - Record flow meter reading prior to deployment of net
  - Lower net to collect sample
  - Record flow meter reading after sampling
  - Wash net down to rinse entire contents into the cod-end
  - Rinse contents of cod-end into a 1 L jar, top up with water
- Samples to be preserved with 50 ml of formalin

3). Ichthyoplankton biomass, abundance and community composition

- 5 x independent samples collected by lowering a weighted 350 µm mesh net to mid – depth and towing horizontally for 1 minute
  - Record flow meter readings prior to deployment of net
    - **Note:** Net 1 has green and yellow striped tape on the frame
  - Lower net to collect sample
  - Record flow meter readings after sampling
  - Wash both nets down to rinse entire contents into the cod-ends
  - Rinse contents of both cod-ends into a 1 L jar, top up with water
- Samples to be preserved with 50 ml of formalin