Enlarged Cotter Reservoir (ECR) Cormorant Management Plan

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1. Purpose of the Plan

This is the third iteration of the Enlarged Cotter Dam (ECD) Cormorant Management Plan.

Initially, cormorant management activities were guided by provisions in an appendix to the ECD Fish Management Plan Version 3 for the filling phase of the ECD (Actew Water, 2014). In 2016, a second iteration was made as an interim plan to guide cormorant management prior to the preparation of an operational Fish Management Plan. However, as filling of the reservoir is now complete and the dam is operational, a new guidance document is required for ongoing cormorant management.

Under current arrangements, there are two broad environmental conditions that trigger management actions relating to cormorants:

1. dissolved oxygen (DO) concentrations, and;
2. cormorant abundance

2. Background

There are three species of cormorants found regularly at Cotter Reservoir, these are Great cormorants (*Phalacrocorax carbo*), Little black cormorants (*Phalacrocorax sulcirostris*) and Little pied cormorants *(Phalacrocorax melanoleucos*). All three species have been found to prey upon Macquarie perch, either confirmed by diet analysis (in the case of Great cormorants and Little black cormorants (Lintermans *et al.* 2011)) or radio-telemetry (radio-tagged Macquarie perch consumed by a Little pied cormorant, (Ebner *et al.* 2008)). Although all three species do prey upon Macquarie perch, it is thought that Great cormorants pose the most significant direct predation risk (Lintermans *et al*. 2011).

Ryan (2010) found that there was increased predation risk in terms of distributional overlap with the location of foraging areas of cormorants and the presence of adult Macquarie perch during the lead up to spawning season, and that the upstream third of the Cotter Reservoir was the critical interface between predator and prey.

Prior to construction of the ECD the interaction between cormorants and Macquarie perch was mediated by abundant emergent macrophytes, which acted as a diurnal refuge for adult Macquarie perch (Ebner and Lintermans 2007; Lintermans *et al*. 2010). These macrophytes have now been inundated by the higher water levels in the dam, with only limited cover provided by the constructed rock reefs and submerged hardwoods.

Abundance

Abundance of cormorant species within the Cotter Catchment continues to vary seasonally in the reservoir following the filling phase, with the greatest numbers occurring during spring and summer. Prior to the construction of the ECD there was no evidence that any species of cormorant bred at Cotter Reservoir.

Cormorants are opportunistic and nomadic, responding to 'boom' conditions, and will breed if resources are sufficient (Kingsford *et al.*, 1999; Dorfman & Kingsford, 2001b). A 'boom' in food resources in the ECR and the presence of emergent flooded trees has resulted in the establishment of a breeding population of cormorants. The establishment of a breeding colony of cormorants in the ECR is undesirable as the energy requirements of maintaining fledglings as well as adults would incur increased pressure on food resources (i.e. Goldfish and Macquarie perch) by cormorants in Cotter Reservoir (Lintermans *et al.*, 2011). Since filling began the enlarged reservoir has seen an increase in the abundance of Goldfish a favoured prey item of cormorants in the Cotter Reservoir (Miller, 1979; Lintermans *et al.*, 2011). This increase in prey abundance and the abundance of partially inundated larger trees (predominantly Eucalypts and pine trees) has provided suitable conditions for nesting.

Distribution

Distribution of all three common cormorant species has been relatively stable during Baseline (2010 – 2013), filling and operational phases with a few exceptions. All three species have been most

abundant in the two upstream sections of the reservoir. Previous research has found that cormorants commonly hunt in depths of less than 5 m (Dorfman & Kingsford, 2001a; Ropert-Coudert *et al.*, 2006) and this depth range is most prevalent in these reservoir sections and provides the greatest area for which effective hunting can be conducted (Ryan, 2010; Ryan *et al.*, 2013).

The Cotter Reservoir contains the only self-sustaining ACT population of the endangered Macquarie perch, and is one of only a handful of such populations in Australia. It is not desirable to allow the establishment of a breeding colony of cormorants on Cotter Reservoir as it will significantly increase the predation pressure on Macquarie perch. The risk posed by cormorants to Macquarie perch is supported by research outcomes (Lintermans *et al.* 2011; Ryan *et al*. 2013) and has been recognised in this, and previous Fish Management Plans.

Impact of low dissolved oxygen

Cormorant predation could also be potentially exacerbated by declines in dissolved oxygen (DO) associated with the decomposing of inundated vegetation as the reservoir filled, which may force Macquarie perch to spend more time in shallow water, or at the water surface, resulting in greater predation risk. However, the risk of low dissolved oxygen has decreased now that the reservoir has filled and has de-stratified (June 2015) and the de-stratification mixers will be operated constantly to minimise the chance of further stratification in subsequent years (Icon Water unpublished data). However low DO levels are still a threat and are includes as a trigger for management action.

3. Triggers for Icon Water management action

Should DO trigger levels in the reservoir be reached (as per Table 1 below), or cormorant abundances exceed established trigger levels (Table 2 below), or cormorant nesting be detected on the ECD, a cormorant control program in the enlarged Cotter Reservoir may commence.

Table 1: Established dissolved oxygen trigger levels and management response in Cotter Dam

Stage	Depth	Triggers		Response
		DO	Duration	
1	3m	Between 4.5 - 6mg/L at 2 or more locations	7 consecutive days	• Undertake Cotter Reservoir weekly field inspections. These inspections involve looking for signs of distressed fish and taking water quality spot measurements at specific habitat locations (habitat and edge locations). Continue to implement for minimum 1 week after DO level returns to above trigger level. • Consider implementation of the cormorant control measures as described below in *Methods for deterring cormorants* • Consider increasing the speed of the destratification units as per the *Destratification Operation Plan* (Appendix F) if not already at full capacity.
2	3m	Between 3 – 4.5mg/L at 2 or more locations	4 consecutive days	• Undertake Cotter Reservoir thrice weekly field inspections. These inspections involve looking for signs of distressed fish and taking water quality spot measurements at specific habitat locations

				(habitat and edge locations). Continue to implement for minimum 1 week after DO level returns to above trigger level • Consider implementation of cormorant control measures as described below in *Methods for deterring cormorants* • Consider release of additional water from Bendora Reservoir or release of water from Cotter Reservoir[1] • Prepare to initiate translocation as per the *ECD Emergency Translocation Program* (Appendix H) • Continue to operate the destratification units at full capacity as per the *Destratification Operation Plan* (Appendix F) where practical
3	3m	Less than 3mg/L at 5 locations or more	3 consecutive days	• Undertake Cotter Reservoir daily field inspections. These inspections involve looking for signs of distressed fish and taking water quality grab samples at specific habitat locations (habitat and edge locations). Continue to implement for minimum 1 week after DO level return to above trigger level. • Consider implementation of cormorant control measures as described below in *Methods for deterring cormorants* • Continue to operate the destratification units at full capacity as per the *Destratification Operation Plan* (Appendix F) • Consider implementation of translocation program as per the *ECD Emergency Translocation Program* (Appendix H)

Note 1: Release of water from Bendora Reservoir to assist in remediating low DO conditions in the Cotter River/reservoir would be in addition to the required environmental flows as per the *Environmental Flow Guidelines 2018*. The FMPWG, would be convened to provide management and technical advice to Icon Water on the health of the Macquarie perch in the Cotter Reservoir and would need to determine whether the benefits to the Macquarie perch would outweigh any detrimental effects to Cotter River ecology.

The Fish Management Program Working Group (FMPWG) will provide oversight for the Icon Water Cormorant Management Program. The day to day duties will be undertaken by an organisation that has the approval of the Fish Management Plan Steering Sub Committee and Icon Water.

Surveys of cormorant abundance

To determine if cormorant numbers are increasing beyond normal maximum levels, monthly cormorant surveys should be undertaken (currently being conducted by University of Canberra as part of the *ECD Fish Monitoring Program*.

A survey from a boat by two researchers, one using binoculars (10 x 42 mm) is to be undertaken monthly with species, abundance and distribution (location of each individual assigned to one of five

approximately equal reservoir segments – see Figure 1) recorded during each survey. If abundances of either Little black or Little pied cormorants rise more the trigger levels for any season (Table 2), then monitoring frequency will increase to weekly. Should abundances of any of the cormorant species remain more than the trigger levels for two consecutive weekly surveys, then cormorant deterrence will commence.

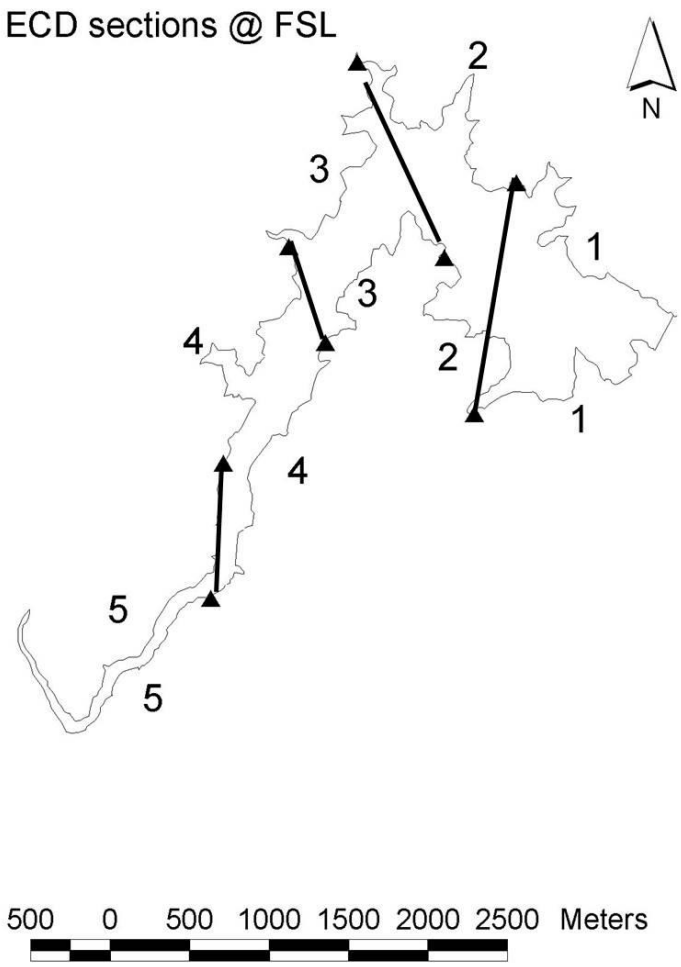

Figure 1: Map of enlarged Cotter Reservoir showing cormorant survey distribution sections

Table 2: Cormorant abundance triggers for the ECD by species and season

Species	Summer	Autumn	Winter	Spring
Great cormorant	50	39	27	43
Little black cormorant	36	8	17	8
Little pied cormorant	55	52	36	14

Cormorant Management

There are three triggers for the potential commencement of cormorant management actions:

1. cormorant numbers detected by monthly surveys increase beyond the prescribed thresholds as defined in Table 2;
2. dissolved oxygen drops below the trigger levels defined in Table 1;
3. cormorant nesting is detected on the ECD

Cormorant management actions are intended to reduce the number of cormorants present at Cotter Reservoir. Details of the cormorant management program on-ground actions, reporting, notification and governance are provided below.

Methods for deterring cormorants

As a **first deterrence measure** cormorants will be continually harassed by boat from 0900 – 1600 hours for three consecutive days. Following three days of harassment a survey will be conducted (twice-weekly for the following week) to assess whether numbers of cormorants has declined. If numbers still remain more than those outlined in Table 2, repeat for another week.

If numbers have not declined after two weeks of harassment, the **second deterrence measure**, firing blank ammunition from a 12 gauge shotgun will be implemented for three days of the following week. The second deterrence measure involves both continual harassment (as per previous) as well as the intermittent discharging of blank rounds (at both perched, swimming and flying individuals). A permit to discharge a firearm will be required from ACT police, compliance with noise pollution guidelines upheld.

Animal ethics approval is not required for management actions (as opposed to research). Following three days of firearm harassment a survey will be conducted to assess whether numbers of cormorants has declined. If abundance has declined to or below the trigger levels in Table 2, then deterrence will cease. Following cessation of deterrence, abundance of cormorants will be monitored twice-weekly for the following week, then once the week after. If abundance remains below the threshold for both weeks, then abundance surveys will revert back to monthly intervals.

If the second measure of deterrence is to be activated, phone and / or email notification will be given to appropriate authorities (Table 3) and warning signs will be placed at each access road to Cotter Reservoir at least 24hr prior to commencement.

Table 3: List of authorities to whom notification of discharge of firearms will be made

Organisation	Phone Number
ACT Police: Firearms Registry	(02)61332122
PCL – Research & Planning	(02) 6207 2117
Icon Water Environment Team	(02) 6180 6299
Icon Water Operations Management	(02) 61752366
Environment Protection Authority	13 22 81

Culling

Should deterrence measures fail to reduce abundance of cormorants below that outlined in Table 2, culling of the three species may be undertaken. Prior to implementation of culling; approval will be sought from the FMPSC. Culling is most likely to be concentrated in the upstream reaches of the reservoir as this is where cormorant numbers are greatest. However, could encompass the entire reservoir with agreement from ACT Police and ACT Parks and Conservation Service.

Culling will involve positioning an experienced licensed shooter close to known roosting locations and culling will be undertaken using a 12-guage shotgun with No. 3 shot. Number of each species to be culled is dependent on the abundance of each species counted each morning before culling. The

number of each species to be culled each day should not exceed the number of individuals that are present for each species above trigger levels (determined from Table 2).

Access to the upstream half of the reservoir will be restricted (by signs at access roads, and by informing Icon Water asset managers, ACT PCS managers and ACT Police) to remove the risk of injury to others. A permit to take will be required from PCS and a permit to discharge a firearm will be required from ACT Police. Notification of culling will be sent out to relevant authorities (Table 3) as well as signs put up at all access roads to the Cotter Reservoir a minimum of 48 hours prior to culling being undertaken.

Initial culling will be undertaken for two consecutive days with a twice-weekly survey of cormorants to be made in the following week to assess whether culling has reduced numbers of cormorants present. If numbers have declined but still remain above that outlined in Table 2, repeat culling for two days then repeat a twice-weekly survey of cormorants in the following week.

Nesting

Cormorants are colonial nesters, and colonies in the early phase of establishment can increase more rapidly than established colonies (Volponi 1999). If the colony is allowed to establish, it is likely that cormorant populations, particularly Great cormorants, which currently exhibit a seasonal presence from September–April (Ryan 2010; Lintermans *et al.* 2011, 2013), will become permanent with higher bird abundances year-round. The establishment of a breeding colony, with its increased predation pressure (to feed chicks), and increased temporal and numerical abundance is not a desirable outcome for the conservation of the Cotter Reservoir Macquarie perch population. The destruction of nests and eggs in the early nesting phase is the most feasible mechanism to discourage the formation of a colony.

Should the presence of nests of any cormorant species be detected, then immediate destruction of the nests should be initiated. Destruction should commence as soon as possible after detection to prevent further breeding activity (egg deposition). Nest destruction would simply comprise the removal of nests from the nesting tree(s), with the nest deconstructed and discarded on the water's surface.

Should nests be found to contain eggs, there are two potential management options:

(1) eggs to be crushed, with any membranes ruptured, and any advanced embryos to be killed by cervical dislocation. Egg remains and constituents would then be discarded into the reservoir.

(2) eggs to be pricked with a needle (preventing embryo development) and returned to the nest for continued 'incubation' by the parent. This would not stimulate re-nesting and new egg-laying by adults (as often occurs following egg destruction in option 1).

A drawback of Option 2 is that it will require marking of pricked eggs and subsequent more intense monitoring (i.e. egg counts and inspections on every monitoring occasion) to make sure that subsequent laying of viable eggs has not occurred. Consequently, Option 1 is preferred.

Should any chicks at an early stage of development be found in nests, then they should be euthanized by cervical dislocation, and the carcases disposed of by burial at an appropriate location. Following nest destruction, twice-weekly monitoring for the first week following destruction and then once weekly for the subsequent week will be conducted to determine if re-nesting occurs at the same location, and to look for nesting in other locations. If no further nesting activity is detected after 2 weeks, nest surveys will cease.

Reporting

A brief report detailing the cormorant survey results and any management actions taken (deterrence, culling, nest destruction, egg destruction, egg pricking) must be provided to Icon Water, the FMPWG and FMPSC within 24 hours of the survey completion (via email). These reports will be formally tabled at the FMPSC meetings.

4. Exit Strategy / Plan Review

Annual or ongoing cormorant control measures are resource-intensive, and not within the current scope of management responsibilities of Icon Water. Wildlife management is generally the responsibility of government departments or agencies (in this case the ACT Parks and Conservation Service) but it is unlikely that this agency will have the resources to undertake ongoing cormorant control. It is recommended that the control measures outlined in this plan should be undertaken until such time that the annual *ECD Fish Monitoring Program* has demonstrated that the Macquarie perch population is regularly recruiting (2 consecutive years of 'average or better' recruitment) and that the adult population levels are stable or increasing over a 3 year time period.

5. References

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