2000/182	Eradicating European carp from Tasmania and implications for national European carp eradication.

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Objectives:

1 Use existing Lake Crescent data to develop a risk assessment model (based on characteristics of recorded catches) that will determine the number of male fish to leave in Lake Crescent while fishing down the females, and the period of fishing required to ensure that the Lake is free of female carp at a level of risk required by managers
2 Conduct the first three years of a strategic fishing plan to eradicate carp from Lake Crescent.
3 Interpret catch per unit effort and mark and recapture data collected since the start of the fishdown (1995) to develop a population model and determine the population characteristics of the Lake Crescent and Lake Sorell carp populations.
4 Use the models developed in steps 1 and 3 to determine the number of male carp to add to Lake Sorell as female aggregators, and the strategic fishing plan necessary to achieve eradication of females from this lake at the level of risk required by managers.
5 Monitor the results of selective fishdown of male carp. Determine the extent to which they validate the model predictions and any problems or concerns in using selective removal of males to eradicate the population.
6 Ensure that the successful results get distributed widely to promote mindset that feral fish can be eradicated and provide the techniques for that eradication.

NON-TECHNICAL SUMMARY:

Carp is a major feral pest in Australia. Development of control options has consistently been identified as a high priority research item. When carp were identified in lakes Crescent (2365 ha) and Sorell (4770 ha) in 1995, the Inland Fisheries Service (IFS) decided to eradicate – both populations. These represent the only extant carp populations in Tasmania and threaten the State's premier trout fishery that attracts 30,000 anglers per year. The presence of an endemic galaxiid in Lakes Crescent and Sorell prevented the use of poisons; draining the lakes was not possible; and the IFS decided on a campaign of containment, and eradication through fishing.

Effective containment was achieved rapidly and effectively by placing a weir with a series of mesh screens at the outlet of Lake Crescent, the downstream lake. Mesh sizes were small enough to prevent eggs and juveniles leaving the lake. In addition the two lakes were closed to anglers to reduce the risks of further translocations. Eradication through fishing in medium to large lakes is not an instantaneous process and in lakes Crescent and Sorell it became a race to fish down the population rapidly

before they had the chance to spawn and add further juveniles to the lakes. Temperatures in these two lakes are at the minimum end of those required for spawning by carp, so spawning is typically restricted to shallow margins of the lake in the summer, preferably during periods of stable or rising water levels. At the start of this eradication, Lake Crescent has very low water levels, and water levels were manipulated to maintain low and falling water levels during the spawning period and thus reduce the risk of additional spawning events. Similar manipulation was not possible for Lake Sorell, where input cannot be controlled and where there is a much wider range of marsh habitat available. More recently, the IFS has started to fence off marsh areas in Lake Sorell to restrict access to these spawning sites. Restriction of spawning has not been entirely successful. While some spawning in Lake Crescent was stimulated to catch the remaining females (eggs were removed after the females were caught), uncontrolled spawning also occurred in 2000 and these juveniles are now being caught. Uncontrolled spawning events took place in Lake Sorell in 1995/96, 1997/98 and 2000. Juveniles from the most recent spawning have been fished intensively. As in the past it has proven more difficult to target adult carp in Lake Sorell.

The effectiveness of the fishing operations in the two lakes was increased by using a variety of gears - fyke nets, seine nets, gillnets, traps, backpack electrofishing, boat electrofishing and combinations of these. Initially the fishing gear types were used somewhat randomly. Later, the IFS started targeting habitat favoured by carp and adapted fishing techniques based on previous catch rates and experience. In 1997, radio tagged male fish were first used as tracker or “Judas” fish to identify aggregations and to help understand carp habitat preference and behaviour. Detected aggregations were targeted using fishing techniques most applicable to the situation. The goal of total eradication was further refined to the eradication of female carp because females are highly fecund (up to 1.5 million eggs for a 6 kg fish) and this intermediate goal was thought to be more readily achievable. From December 1999, male fish were routinely tagged and returned to the lakes with the hope of promoting mixed aggregations of female and male fish. Release of tagged male carp back into the lake also made it possible to estimate the remaining population size, especially of female fish.

An important part of this project has been to monitor the success of the fishdown using a mark and recapture program. Initial population estimates were developed by IFS using standard Peterson estimates. This approach had the difficulty of deciding which data sets to use and could not be used to estimate tag loss and natural mortality. A daily mark and recapture model was developed to use all the mark and recapture information, which enabled the continual marking and release of fish. Tag loss was estimated using double-tagged fish and found to vary between small and large tags. Difficulties in estimating tag loss led to the recommendation that in future all tagged fish be double tagged with large tags (Traditionally you tag with one tag of each type – but we know the small tags are shed more readily!). Natural mortality was estimated but found to be negligible. The population size in Lake Crescent was estimated at 32 fish in November 2003. No mark and recapture population estimate was possible for Lake Sorell as to date the fish have been too small to sex and therefore all fish captured in this lake have been killed. A major constraint on the use of the model was inconsistency in data collection over the years. An ACCESS database was developed to assist consistent data entry, including the cross-validation of biological and catch data.

The use of radio tracked fish increased the effectiveness of the fishing by signalling when an aggregation was occurring. Differing behaviours of radio tracked fish suggests that carp in the lakes can adopt resident or mobile behaviours. While mobile fish can be caught in any aggregation, resident fish rarely move from their habitat unless a spawning aggregation is developing. Mark and recapture data also indicate that there is a larger than expected proportion of fish that are not recaptured after initial tagging. While this may be partly explained by the loss of tags before they become securely embedded in the flesh, there is also the suggestion that the tagged carp have varying degrees of vulnerability to recapture. Interestingly, there also seems to be a group of fish that are consistently caught at above the expected rate, leading to a larger number of high multiple recaptures than expected. This varying vulnerability could have serious implications for removing the final fish from the lake. Radio tracking resident and mobile fish may be necessary to target these last few fish.

Returning male fish to the lake to serve as a focus for aggregations that would attract female fish met with varying success. It is recommended that male fish be returned to the lake only in the numbers necessary to have radio tracked fish covering all behaviour types and for population estimates.

Trends in catch data suggest that the probability of catching a fish per days fishing effort has declined since 1998. If this decline continues then it is estimated that 213-435 fishing days would be required to remove the remaining 32 fish from Lake Crescent. However, data from the first half of 2003 suggests that the decline in capture probability has levelled off, in which case 140 days of fishing effort would be required to remove the last adults. However, at the moment the days of fishing required to eradicate carp from these two lakes will not be dictated by removal of the last current adult, but by removal of the last of the juveniles spawned in 2000/01 that are now evident in the population. Continued improvements in fishing effectiveness will be required to eradicate carp from Lake Sorell. Exclusion fences restricting access to the marshes used as spawning sites are now being used along with specifically designed traps. Ongoing development of carp attractants and repellents in the US may provide an additional option in the future, with the possible use of pheromones to attract fish into traps.

OUTCOMES ACHIEVED:

A daily mark and recapture model was developed for the ongoing carp eradication in lakes Sorell and Crescent and used to estimate the current population size. The model can be generalised to other lakes. An associated database was developed to reduce errors in data recording and transcription. Analysis of catch and effort data and the data on carp tagged and recaptured multiple times has shown the variability of behaviours in the carp populations that has important implications for the ongoing eradication. Observations on the effectiveness of different approaches to carp eradication have been documented to assist other groups considering eradicating carp through fishing.

KEYWORDS:

Carp, Eradication, Control, Radio tracking, Mark and Recapture, Population Estimation