POTENTIAL IMPACTS OF THE ASIAN CLIMBING PERCH ON QUEENSLAND

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Abstract

Risk of establishment of the freshwater climbing perch (Anabas testudineus) in mainland Queensland from the Torres Strait is high. The species is dispersed through human assistance and/or attributes that assist its own spread. The species has the potential to out-compete native freshwater and estuarine species, and has sharp well-developed gill plates and spines that may choke and kill predatory species like barramundi if swallowed. The presence of climbing perch would severely impact Queensland's inshore and freshwater fisheries, both commercial and recreational. The net present value of expected lost fishing activity due to build-up of the climbing perch is $48.5 million when the probability of introduction is 20 per cent. Analysis of potential spending on an entry prevention strategy for the climbing perch can be justified, with a benefit cost ratio of 150 to 1.

Keywords: Invasive species, impact, risk.

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1. Introduction

The freshwater climbing perch *Anabas testudineus* (listed as 'noxious' under Schedule 5A of Queensland's Fisheries Regulation 1995) was introduced to West Papua via Indonesia in the 1980s. It has since spread to almost all freshwater bodies within the Indonesian province and neighbouring Papua New Guinea. In 2005, climbing perch were discovered within Queensland's territorial waters, specifically Saibai Island (Torres Strait).

The climbing perch is a prized aquaculture species throughout most of Asia, thriving in fresh and brackish water. The species is known for its ability to traverse across land to a new water body when overcrowding creates limited food supply (Liem, 1987). The climbing perch can breathe air while on land and is capable of spending days out of water provided the breathing organ remains moist (Storey *et al.,* 2002). The spread through Papua New Guinea and some Pacific Islands has been a combination of its use as an aquaculture resource; its own ability to move water bodies; and by indigenous people who travel with the live fish wrapped in damp leaves for food (Miller *et al.*, 1995). As climbing perch are a popular food fish in Asia, it is possible that expatriates from India, Bangladesh and other south-east Asian countries and may also provide anthropogenic assistance to its spread.

The effects of the climbing perch on native fish and other fauna can be devastating. Climbing perch are expected to out-compete native freshwater and estuarine species. In addition, the fish has sharp dorsal and opercular spines which are extended when the fish is ingested by predatory species (Hitchcock, 2007). Villagers in Papua New Guinea have noticed substantial mortalities in piscivorous birds such as the cormorant (*Phalacrocorax.* spp.) and darters (*Anbinga melanogaster*), as well as Arafura file snakes (*Acrochordus arafurae*) after ingesting climbing perch (Miller *et al.,* 1995; Storey *et al.,* 2002; Hitchcock, 2006; Hitchcock, 2007). Similar outcomes are expected to occur in Queensland birds, reptiles, animals and predatory fish.

The climbing perch is known to be established on Saibai Island in the Torres Strait, but is not believed to be currently present in mainland Queensland (Hitchcock, 2006). However, the risk of climbing perch to mainland Queensland is high, as regular trade between Torres Strait islands provides the ideal vector for a climbing perch incursion into mainland Australia.

It is also noted that Australian pelicans *Pelecanus conspicillatus* nesting on Kerr Islet, 45km south of PNG and 72km south-west of Boigu Island, have ingested and regurgitated the climbing perch (Hitchcock, 2007). Although Hitchcock (2007) indicates that the fish were dead, anecdotal evidence suggests that climbing perch may survive ingestion and regurgitation by pelicans, which may also assist transportation of the climbing perch to Queensland.

The climbing perch has the potential to spread throughout Queensland and across northern Australia and possibly into the Murray-Darling system, constrained only by cold temperatures. However, the climbing perch may partially adapt to critical minimum temperatures, similar to the cane toad (*Bufo marinus*) where adults can withstand minimum temperatures of 6°C to 12°C depending on the thermal history of the toad in the embryonic and larval stages of its life (van Dam, Walden & Begg 2002).

A number of co-ordinated actions need to be taken in order to prevent the arrival of this noxious fish species in Queensland. A welfare cost-benefit analysis has been produced to justify expenditure on actions to prevent their spread into Queensland's mainland water systems. If these fish are allowed to enter Queensland waters and spread south and west throughout the state, they will affect our native fish, reptile, animal and bird species. This will have implications for the Department of Primary Industries and Fisheries' sustainable fisheries, as well as environmental values associated with biodiversity.

To achieve the aim of preventing entry to Queensland of the climbing perch, it is necessary for the Queensland Government to be prepared and focused, with a proactive suite of actions. The only way to prevent the establishment of this species in Queensland is through prevention education among the Torres Strait islander populations and an early detection program. This suite of actions may include: an initial survey, community consultation, communication strategy, monitoring of Far North Queensland rivers and estuaries, rapid response procedure, control and research program, and supporting procedures and policies to assist all stakeholders in managing this pest fish species.

2. Method of evaluation

Cost benefit analysis

Cost-benefit analysis (CBA) has been used to evaluate and compare the benefits flowing from an entry prevention strategy for the climbing perch. In addition to directly measurable financial costs and benefits, this analysis also includes indirect measures of economic welfare, specifically in recreational fishing where the catch is not directly valued.

The CBA framework uses initial setup costs, the benefits flowing from an entry prevention strategy and any ongoing costs of the strategy to derive two economic variables: net present value (NPV) and benefit-cost ratio (BCR). To account for the time preference of money (opportunity cost), future benefits and costs have been discounted to 2007 values using a real discount rate of 5%. All dollar costs and benefits are expressed in constant dollar terms and discounted to the current year. In this report, the effects of an entry prevention strategy are compared over a 30 year time horizon.

The NPV of a stream of benefits (or costs) is the sum of the discounted yearly values. The NPV is given by:

NPV = present value of benefits – present value of program costs

A positive NPV indicates that over the time horizon considered, the benefits of the program or actions outweigh the costs. The benefit-cost ratio (BCR) is the ratio of the benefits to the capital costs of the program:

BCR = present value of benefits / present value of program costs

A BCR greater than one indicates that the discounted sum of the net benefits are greater than the capital costs, a BCR of less than one indicates that net benefits are smaller than the capital costs, and a negative BCR indicates that net benefits are negative.

The BCR and NPV measures are related, in that when the BCR of a project is one, the NPV is zero. Both the NPV and BCR are affected by the magnitude of the discount rate (usually a higher discount rate will emphasise the setup costs, reducing the NPV and BCR).

Defining the costs and benefits

It is difficult to evaluate the effects of climbing perch entry prevention strategies for two reasons. Firstly, the full effects of climbing perch on the Australian natural environment are not known, although it is expected there will be varying impacts on fish, reptile, bird and animal species.

Secondly, no pest fish entry prevention strategy can completely remove the possibility of the climbing perch entering and becoming established in Australia. Best available information from other countries was used to build a forecast of individual parameters of impact, based on expert opinion. The potential impacts on fish species are analysed, along with varying risks of entry occurring. The uncertainty of the forecasts was signalled by using alternative values for some parameters instead of a single figure.

The major parametric assumptions of the model are:

Only the impacts to the recreational and commercial fishing industries have been estimated. It is acknowledged that the impacts to other reptiles and fauna may be significant, but have not been included in this analysis at this stage. Impacts on these other species will increase the benefits received from any entry prevention activities undertaken.

The maximum impact of the climbing perch on commercial and recreational fisheries has been assumed in the base case to be a 35 per cent reduction in catch yields for commercial fishing and a 25 per cent reduction for recreational fishing. Two alternate scenarios have also been modelled, first with 20 per cent commercial reduction and 14.3 per cent recreational reduction, and second with only 10 per cent commercial reduction and 7.1 per cent recreational reduction in fish yields.

The welfare loss associated with build-up of the climbing perch is calculated using gross value of production for commercial inshore fishing, and using expenditure for inshore and inland recreational fishing. For the former the main impact on commercial fishing will be loss of income through reduced catch yield. The impact on recreational fishing will manifest itself in a reduction of most fishing-related expenditures including bait, ice, boat hire, food, drink, fuel, accommodation, and fishing competitions. Note that capital expenditure on tackle and boats is also likely to be impacted by climbing perch, however, this impact has not been captured by this study. Gross value of production from inshore commercial fishing is $18.9m (CFish data), and the expenditure on recreational fishing is $50.4m (RFish data).

Climing perch is assumed to reach each major Queensland region one year after the previous region, allowing time for the fish stock in the previous region to build-up. Spread at a faster rate than this will increase the BCR of entry prevention activities, while slower spread will decrease the BCR of these activities.

The impact of the climbing perch on each region follows a logistic growth function with the full impact not reached until 30 years after establishment. If the full impact is reached in a shorter time period the BCR of entry prevention activities will be higher, while if the full impact is not felt for longer than 30 years the BCR will be lower.

The expected cost of an entry prevention program is $165,000 capital costs and $210,000 per annum operating costs. These figures include the expenses of a detailed survey in the Torres Strait, purchase and operating costs of one boat, and two full time equivalents (FTEs) in addition to the survey team.

Table 1: Major variables for benefit cost analysis

Total yearly value of fisheries ($'000)

Commercial	Recreational	Total
$18,907	$50,360	$69,267
Inshore	Inshore & inland	

Discount rate and reductions in value

Discount rate	5%
Max reduction in commercial	35%
Max reduction recreational	25%

Sensitivity Analysis

To show the sensitivity of the analysis to different probabilities of entry, a set of expected values of lost fishing value were calculated, using a geometric distribution to model the likelihood of entry each year. Table 2 gives the lost fishing value over 30 years discounted at 5.0 per cent, due to the entry and spread of the climbing perch, with different probabilities of entry to Queensland, and different maximum effects on commercial and recreational fish yields.

In addition, entry prevention activities only reduce the probability of entry (rather than removing the possibility of entry altogether), so the value of entry prevention activities depends on the change in entry probability. The extent of change in the entry probability associated with different levels of entry prevention program expenditure is unknown and likely to be dependent on a range of factors. Therefore, NPV and BCR with the conservative base case program expenditure of $165,000 capital costs and $210,000 per annum operating costs, are compared for a medium reduction in entry probability and a larger reduction in entry probability, with a discount rate of 5.0 per cent. Tables 3 and 4 show the net present value (NPV) and benefit cost ratio (BCR) of the base case conservative entry prevention strategy, with different maximum effects on commercial and recreational fish yields. Tables 5 and 6 present the same figures but with larger capital ($525,000) and annual ongoing expenditure ($560,000) on the entry prevention strategy.

3. Parameters and results

Table 2 reports expected value of lost fishing over 30 years with different probabilities of entry to Queensland, and different maximum effects on commercial and recreational fish yields.

Table 2: Expected lost value of fishing over 30 years

	Reduction in yield		
Entry probability	Alternate case: 10% commercial 7% recreational ($'000)	Alternate case: 20% commercial 14% recreational ($'000)	Base case: 35% commercial 25% recreational ($'000)
1%	1,382	2,767	4,839
2%	2,639	5,283	9,239
5%	5,785	11,582	20,254
10%	9,523	19,063	33,338
20%	13,846	27,717	48,473
50%	18,474	36,982	64,676
100%	20,510	41,058	71,804

The values in Table 2 are based on the assumption that the climbing perch becomes established in each major region one year after the previous region. If the climbing perch has an entry probability of 100 per cent (will definitely enter and establish in Queensland), and the maximum reduction in commercial and recreational fish yields are 35 per cent and 25 per cent respectively, the expected present value of this loss is over $71.8m to Queensland for a 30 year time frame. On the other hand, if the entry probability is only 1 per cent and the maximum reductions in yield are 10 per cent commercial and 7 per cent recreational, the expected present value of the loss to Queensland is only $1.4m over 30 years.

The figures reported in Table 3 and Table 4 give the net benefit of climbing perch entry prevention activities in the Torres Strait region for three maximum effects on commercial fisheries – 10, 20 and 35 per cent reduction in yields – and three corresponding effects on recreational fisheries – 7, 14 and 25 per cent reduction in activity. In these two tables, the upfront or capital costs of the entry prevention activities are assumed to be $165,000, with annual operating costs of $210,000. Full tables showing the expected lost value of fishing with different probabilities of entry and for different maximum reductions in fish yield, with base case entry prevention activity costs, are shown in Tables A1 to A6 (see Appendix A).

Table 3 refers to a conservative improvement in the entry probability, from 20 per cent (a 1 in 5 year event) to 5 per cent (a 1 in 20 year event).

Table 3: NPV and BCR with improvement in entry probability from 20 per cent to 5 per cent

	Reduction in yield		
	Alternate case: 10% commercial 7% recreational	Alternate case: 20% commercial 14% recreational	Base case: 35% commercial 25% recreational
NPV	$4.5m	$12.6m	$24.7m
BCR	28.3	77.2	150.5

Even with only a 10 per cent reduction in commercial fishing yields and 7% reduction in recreational catch yield, entry prevention activities that reduce the risk of climbing perch entry show a significant positive net benefit and benefit cost ratio.

Table 4 refers to a larger improvement in the entry probability, from 20 per cent (a 1 in 5 year event) to 2 per cent (a 1 in 50 year event).

Table 4: NPV and BCR with larger improvement in entry probability from 20 per cent to 2 per cent

	Reduction in yield		
	Alternate case: 10% commercial 7% recreational	Alternate case: 20% commercial 14% recreational	Base case: 35% commercial 25% recreational
NPV	$7.7m	$18.9m	$35.7m
BCR	47.4	115.4	217.2

At a maximum effect of 10 per cent commercial and 7 per cent recreational, climbing perch entry prevention activities produce significantly positive NPVs and BCRs, indicating the entry prevention activities are justified.

To assess the viability of a larger and more expensive entry prevention strategy with increased education and awareness training for the Torres Strait people, and with increased surveillance and monitoring, the capital costs and operating expenses have been doubled. This allows comparison of the net present value of each spending strategy. Tables 5 and Table 6 give the net benefits of larger spending on climbing perch entry prevention activities in the Torres Strait region, but with the same reductions in the probability of entry, and again for three maximum effects on commercial and recreational fisheries. In these two tables, the upfront or capital costs of the entry prevention activities are assumed to be $525,000, with annual operating costs of $560,000.

Table 5: NPV and BCR, with increased costs, improvement in entry probability from 20 per cent to 5 per cent

	Reduction in yield		
	Alternate case: 10% commercial 7% recreational	Alternate case: 20% commercial 14% recreational	Base case: 35% commercial 25% recreational
NPV	-$8.8m	$6.6m	$18.7m
BCR	-15.7	13.5	36.5

Table 6: NPV and BCR, with increased costs, larger improvement in entry probability from 20 per cent to 2 per cent

	Reduction in yield		
	Alternate case: 10% commercial 7% recreational	Alternate case: 20% commercial 14% recreational	Base case: 35% commercial 25% recreational
NPV	-$8.5m	$12.9m	$29.7m
BCR	-15.1	25.5	57.5

It must be stressed that environmental costs of a climbing perch incursion into Queensland could not be included in the analysis for lack of resources. If they were, the net present values would show an even larger net benefit to the entry prevention program, and the negative net present value when the impact on fishing is smallest, would possibly become a positive value.

Tables 3, 4, 5 and 6 show the value of an entry prevention and monitoring program for the Torres Strait and North Queensland region. Irrespective of expenditure on capital and operating costs, a reduction in the chance of climbing perch entry and establishment by an extra 3 per cent increases the expected net benefits of the activities by between $0.3m and $11m.

4. Conclusion

The figures in this analysis do not attempt to include environmental impacts of the spread of climbing perch to Queensland. Rather, they show that even if the scope of the analysis is tightly restricted to the monetised economic impact of an incursion on recreational and commercial inshore fishing, investment in entry prevention and monitoring programs is justified. The inclusion of environmental and ecological impacts would further improve the case for the type of activity discussed in this report.

The presence of climbing perch would severely impact Queensland's inshore and freshwater fisheries, both commercial and recreational. The base case scenario presented with a maximum impact of 35 per cent on commercial inshore fishing and 25 per cent on inshore and inland recreational fishing, gives an expected lost value of fishing of $48.5m when the probability of entry is 20 per cent (a 1 in 5 year event). The expected lost value of fishing activity increases as the climbing perch probability of entry increases.

An educational program throughout the Torres Strait about the dangers of the climbing perch introduction to mainland Australia is expected to have significant benefits if the education reduces the probability of entry. Program expenditure of $165,000 capital costs and $210,000 per annum operating costs, gives a net present value of $24.7m to Queensland when the probability of entry is reduced from 20 per cent to 5 per cent. This represents a benefit cost ratio of 150 to 1.

Appendix A

Table A1: Maximum reduction in commercial fishing 50% and in recreational fishing 36%

Queensland recreational & inshore commercial fisheries (cumulative impact)

Total yearly value of fisheries ($'000)

Commercial	Recreational	Total
$18,907	$50,360	$69,267
Inshore	Inshore & inland	

Discount rate and reductions in value

Discount rate	5%
Max reduction in commercial	50%
Max reduction recreational	36%

Table 1 - Expected value of lost activity ($'000) at yearly likelihood of entry over 30 years

	One in 100 year event (p=0.01)	One in 50 year event (p=0.02)	One in 20 year event (p=0.05)	One in 10 year event (p=0.10)	One in 5 year event (p=0.20)	One in 2 year event (p=0.50)	Yearly event (p=1.00)
NPV	$6,912	$13,197	$28,932	$47,622	$69,241	$92,388	$102,569

Table 2 - Savings due to reductions in entry probabilities ($'000)

Savings from moving from entry probability…	… to entry probability 0.01	0.02	0.05	0.10	0.20	0.50
0.02	$6,285					
0.05	$22,020	$15,736				
0.10	$40,709	$34,425	$18,689			
0.20	$62,329	$56,044	$40,309	$21,620		
0.50	$85,475	$79,191	$63,455	$44,766	$23,146	
1.00	$95,656	$89,372	$73,636	$54,947	$33,328	$10,181

E.g.: If we assume that some entry prevention activity reduces the probability of entry from 0.50 to 0.05, the value of this activity is given as $92,388,000 - $28,932,000 = **$63,455,000** over thirty years.

Do nothing vs Entry Prevention: Economic indicators ($'000) for activities to reduce entry likelihoods

Capital costs of containment (NPV)	$165	Operating costs (NPV) ($210,000 p.a.)	$3,390

0.20 to 0.02	**$56,044**
NPV	$52,490
BCR	319.1

0.20 to 0.05	**$40,309**
NPV	$36,754
BCR	223.8

0.20 to 0.10	**$21,620**
NPV	$18,065
BCR	110.5

0.50 to 0.02	**$79,191**
NPV	$75,636
BCR	459.4

0.50 to 0.05	**$63,455**
NPV	$59,900
BCR	364.0

0.50 to 0.10	**$44,766**
NPV	$41,211
BCR	250.8

1.00 to 0.02	**$89,372**
NPV	$85,817
BCR	521.1

1.00 to 0.05	**$73,636**
NPV	$70,082
BCR	425.7

1.00 to 0.10	**$54,947**
NPV	$51,392.7
BCR	312.5

Table A2: Maximum reduction in commercial fishing 35% and in recreational fishing 25%

Queensland recreational & inshore commercial fisheries (cumulative impact)

Total yearly value of fisheries ($'000)

Commercial	Recreational	Total
$18,907	$50,360	$69,267
Inshore	Inshore & inland	

Discount rate and reductions in value

Discount rate	5%
Max reduction in commercial	35%
Max reduction recreational	25%

Table 1 - Expected value of lost activity ($'000) at yearly likelihood of entry over 30 years

	One in 100 year event (p=0.01)	One in 50 year event (p=0.02)	One in 20 year event (p=0.05)	One in 10 year event (p=0.10)	One in 5 year event (p=0.20)	One in 2 year event (p=0.50)	Yearly event (p=1.00)
NPV	$4,839	$9,239	$20,254	$33,338	$48,473	$64,676	$71,804

Table 2 - Savings due to reductions in entry probabilities ($'000)

Savings from moving from entry probability…	… to entry probability 0.01	0.02	0.05	0.10	0.20	0.50
0.02	$4,400					
0.05	$15,415	$11,016				
0.10	$28,499	$24,099	$13,083			
0.20	$43,634	$39,234	$28,218	$15,135		
0.50	$59,837	$55,438	$44,422	$31,339	$16,204	
1.00	$66,965	$62,565	$51,550	$38,466	$23,331	$7,127

E.g.: If we assume that some entry prevention activity reduces the probability of entry from 0.50 to 0.05, the value of this activity is given as $64,676,000 - $20,254,000 = **$44,422,000** over thirty years.

Do nothing vs Entry Prevention: Economic indicators ($'000) for activities to reduce entry likelihoods

Capital costs of containment (NPV)	$165	Operating costs (NPV) ($210,000 p.a.)	$3,390

0.20 to 0.02	**$39,234**
NPV	$35,679
BCR	217.2

0.20 to 0.05	**$28,218**
NPV	$24,664
BCR	150.5

0.20 to 0.10	**$15,135**
NPV	$11,580
BCR	71.2

0.50 to 0.02	**$55,438**
NPV	$51,883
BCR	315.4

0.50 to 0.05	**$44,422**
NPV	$40,867
BCR	248.7

0.50 to 0.10	**$31,339**
NPV	$27,784
BCR	169.4

1.00 to 0.02	**$62,565**
NPV	$59,011
BCR	358.6

1.00 to 0.05	**$51,550**
NPV	$47,995
BCR	291.9

1.00 to 0.10	**$38,466**
NPV	$34,911.5
BCR	212.6

Table A3: Maximum reduction in commercial fishing 20% and in recreational fishing 14%

Queensland recreational & inshore commercial fisheries (cumulative impact)

Total yearly value of fisheries ($'000)

Commercial	Recreational	Total
$18,907	$50,360	$69,267
Inshore	Inshore & inland	

Discount rate and reductions in value

Discount rate	5%
Max reduction in commercial	20%
Max reduction recreational	14%

Table 1 - Expected value of lost activity ($'000) at yearly likelihood of entry over 30 years

	One in 100 year event (p=0.01)	One in 50 year event (p=0.02)	One in 20 year event (p=0.05)	One in 10 year event (p=0.10)	One in 5 year event (p=0.20)	One in 2 year event (p=0.50)	Yearly event (p=1.00)
NPV	$2,767	$5,283	$11,582	$19,063	$27,717	$36,982	$41,058

Table 2 - Savings due to reductions in entry probabilities ($'000)

Savings from moving from entry probability… \ … to entry probability	0.01	0.02	0.05	0.10	0.20	0.50
0.02	$2,516					
0.05	$8,815	$6,299				
0.10	$16,296	$13,780	$7,481			
0.20	$24,950	$22,434	$16,135	$8,654		
0.50	$34,215	$31,700	$25,401	$17,920	$9,265	
1.00	$38,291	$35,775	$29,476	$21,995	$13,341	$4,076

E.g.: If we assume that some entry prevention activity reduces the probability of entry from 0.50 to 0.05, the value of this activity is given as $36,982,000 - $11,582,000 = **$25,401,000** over thirty years.

Do nothing vs Entry Prevention: Economic indicators ($'000) for activities to reduce entry likelihoods

Capital costs of containment (NPV)	$165	Operating costs (NPV) ($210,000 p.a.)	$3,390

0.20 to 0.02	**$22,434**
NPV	$18,880
BCR	115.42

0.20 to 0.05	**$16,135**
NPV	$12,581
BCR	77.25

0.20 to 0.10	**$8,654**
NPV	$5,100
BCR	31.91

0.50 to 0.02	**$31,700**
NPV	$28,145
BCR	171.58

0.50 to 0.05	**$25,401**
NPV	$21,846
BCR	133.40

0.50 to 0.10	**$17,920**
NPV	$14,365
BCR	88.06

1.00 to 0.02	**$35,775**
NPV	$32,221
BCR	196.28

1.00 to 0.05	**$29,476**
NPV	$25,922
BCR	158.10

1.00 to 0.10	**$21,995**
NPV	$18,440.6
BCR	112.76

Table A4: Maximum reduction in commercial fishing 10% and in recreational fishing 7%

Queensland recreational & inshore commercial fisheries (cumulative impact)

Total yearly value of fisheries ($'000)

Commercial	Recreational	Total
$18,907	$50,360	$69,267
Inshore	Inshore & inland	

Discount rate and reductions in value

Discount rate	5%
Max reduction in commercial	10%
Max reduction recreational	7%

Table 1 - Expected value of lost activity ($'000) at yearly likelihood of entry over 30 years

	One in 100 year event (p=0.01)	One in 50 year event (p=0.02)	One in 20 year event (p=0.05)	One in 10 year event (p=0.10)	One in 5 year event (p=0.20)	One in 2 year event (p=0.50)	Yearly event (p=1.00)
NPV	$1,382	$2,639	$5,785	$9,523	$13,846	$18,474	$20,510

Table 2 - Savings due to reductions in entry probabilities ($'000)

Savings from moving from entry probability…	… to entry probability 0.01	0.02	0.05	0.10	0.20	0.50
0.02	$1,257					
0.05	$4,403	$3,147				
0.10	$8,140	$6,884	$3,737			
0.20	$12,463	$11,207	$8,060	$4,323		
0.50	$17,092	$15,835	$12,689	$8,952	$4,628	
1.00	$19,128	$17,871	$14,725	$10,987	$6,664	$2,036

E.g.: If we assume that some entry prevention activity reduces the probability of entry from 0.50 to 0.05, the value of this activity is given as $18,474,000 - $5,785,000 = **$12,689,000** over thirty years.

Do nothing vs Entry Prevention: Economic indicators ($'000) for activities to reduce entry likelihoods

Capital costs of containment (NPV)	$165	Operating costs (NPV) ($210,000 p.a.)	$3,390

0.20 to 0.02	**$11,207**
NPV	$7,652
BCR	47.38

0.20 to 0.05	**$8,060**
NPV	$4,506
BCR	28.31

0.20 to 0.10	**$4,323**
NPV	$768
BCR	5.66

0.50 to 0.02	**$15,835**
NPV	$12,281
BCR	75.43

0.50 to 0.05	**$12,689**
NPV	$9,134
BCR	56.36

0.50 to 0.10	**$8,952**
NPV	$5,397
BCR	33.71

1.00 to 0.02	**$17,871**
NPV	$14,316
BCR	87.77

1.00 to 0.05	**$14,725**
NPV	$11,170
BCR	68.70

1.00 to 0.10	**$10,987**
NPV	$7,432.8
BCR	46.05

Table A5: Maximum reduction in commercial fishing 5% and in recreational fishing 3%

Queensland recreational & inshore commercial fisheries (cumulative impact)

Total yearly value of fisheries ($'000)

Commercial	Recreational	Total
$18,907	$50,360	$69,267
Inshore	Inshore & inland	

Discount rate and reductions in value

Discount rate	5%
Max reduction in commercial	5%
Max reduction recreational	3%

Table 1 - Expected value of lost activity ($'000) at yearly likelihood of entry over 30 years

	One in 100 year event (p=0.01)	One in 50 year event (p=0.02)	One in 20 year event (p=0.05)	One in 10 year event (p=0.10)	One in 5 year event (p=0.20)	One in 2 year event (p=0.50)	Yearly event (p=1.00)
NPV	$600	$1,145	$2,511	$4,134	$6,011	$8,021	$8,905

Table 2 - Savings due to reductions in entry probabilities ($'000)

Savings from moving from entry probability…	… to entry probability 0.01	0.02	0.05	0.10	0.20	0.50
0.02	$545					
0.05	$1,911	$1,366				
0.10	$3,534	$2,988	$1,622			
0.20	$5,411	$4,865	$3,499	$1,877		
0.50	$7,421	$6,875	$5,510	$3,887	$2,010	
1.00	$8,305	$7,760	$6,394	$4,772	$2,895	$884

E.g.: If we assume that some entry prevention activity reduces the probability of entry from 0.50 to 0.05, the value of this activity is given as $8,021,000 - $2,511,000 = **$5,510,000** over thirty years.

Do nothing vs Entry Prevention: Economic indicators ($'000) for activities to reduce entry likelihoods

Capital costs of containment (NPV)	$165	Operating costs (NPV) ($210,000 p.a.)	$3,390

0.20 to 0.02	**$4,865**
NPV	$1,311
BCR	8.94

0.20 to 0.05	**$3,499**
NPV	-$55
BCR	0.67

0.20 to 0.10	**$1,877**
NPV	-$1,678
BCR	-9.17

0.50 to 0.02	**$6,875**
NPV	$3,321
BCR	21.13

0.50 to 0.05	**$5,510**
NPV	$1,955
BCR	12.85

0.50 to 0.10	**$3,887**
NPV	$333
BCR	3.02

1.00 to 0.02	**$7,760**
NPV	$4,205
BCR	26.49

1.00 to 0.05	**$6,394**
NPV	$2,839
BCR	18.21

1.00 to 0.10	**$4,772**
NPV	$1,217.0
BCR	8.38

Table A6: Maximum reduction in commercial fishing 1% and in recreational fishing 0.7%

Queensland recreational & inshore commercial fisheries (cumulative impact)

Total yearly value of fisheries ($'000)

Commercial	Recreational	Total
$18,907	$50,360	$69,267
Inshore	Inshore & inland	

Discount rate and reductions in value

Discount rate	5%
Max reduction in commercial	1.0%
Max reduction recreational	0.7%

Table 1 - Expected value of lost activity ($'000) at yearly likelihood of entry over 30 years

	One in 100 year event (p=0.01)	One in 50 year event (p=0.02)	One in 20 year event (p=0.05)	One in 10 year event (p=0.10)	One in 5 year event (p=0.20)	One in 2 year event (p=0.50)	Yearly event (p=1.00)
NPV	$136	$260	$571	$940	$1,367	$1,823	$2,024

Table 2 - Savings due to reductions in entry probabilities ($'000)

Savings from moving from entry probability…	… to entry probability 0.01	0.02	0.05	0.10	0.20	0.50
0.02	$124					
0.05	$435	$311				
0.10	$803	$679	$369			
0.20	$1,230	$1,106	$796	$427		
0.50	$1,687	$1,563	$1,252	$884	$457	
1.00	$1,888	$1,764	$1,453	$1,085	$658	$201

E.g.: If we assume that some entry prevention activity reduces the probability of entry from 0.50 to 0.05, the value of this activity is given as $1,823,000 - $571,000 = **$1,252,000** over thirty years.

Do nothing vs Entry Prevention: Economic indicators ($'000) for activities to reduce entry likelihoods

Capital costs of containment (NPV)	$165	Operating costs (NPV) ($210,000 p.a.)	$3,390

0.20 to 0.02	**$1,106**	**0.20 to 0.05**	**$796**	**0.20 to 0.10**	**$427**
NPV	-$2,449	NPV	-$2,759	NPV	-$3,128
BCR	-13.84	BCR	-15.72	BCR	-17.96

0.50 to 0.02	**$1,563**	**0.50 to 0.05**	**$1,252**	**0.50 to 0.10**	**$884**
NPV	-$1,992	NPV	-$2,302	NPV	-$2,671
BCR	-11.07	BCR	-12.95	BCR	-15.19

1.00 to 0.02	**$1,764**	**1.00 to 0.05**	**$1,453**	**1.00 to 0.10**	**$1,085**
NPV	-$1,791	NPV	-$2,101	NPV	-$2,470.1
BCR	-9.85	BCR	-11.73	BCR	-13.97

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