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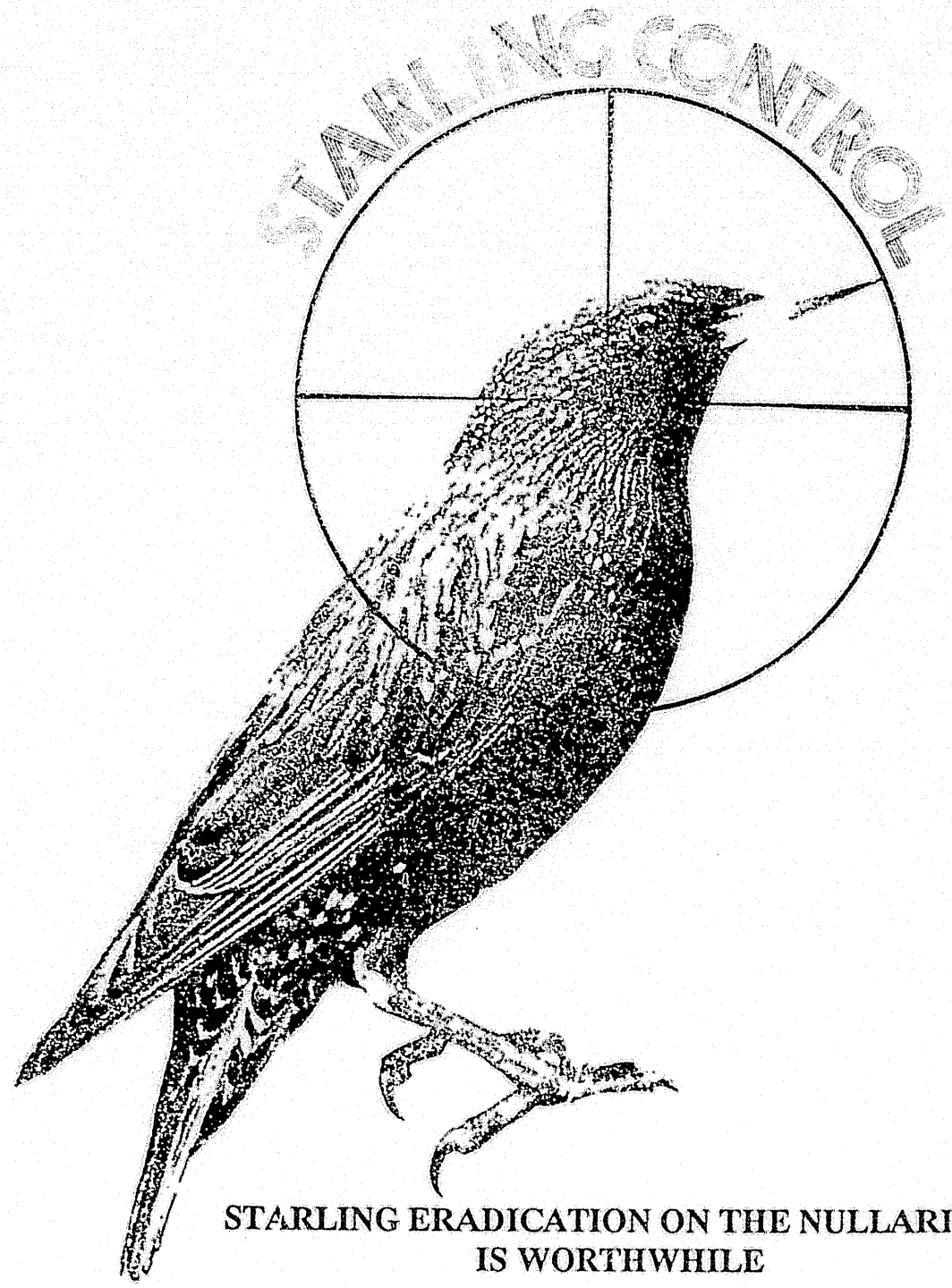

STARLING ERADICATION ON THE NULLARBO IS WORTHWHILE

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STARLING ERADICATION ON THE NULLARBOR IS WORTHWHILE

Introduction

Although common starlings (*Sturnus vulgaris*) (referred to as starlings in this paper) were introduced in Victoria by private individuals, prior to Acclimatisation Society releases in the 1860s, it wasn't until the later releases occurred that starlings became firmly established in Victoria (Long 1981). Consideration was given to the introduction of starlings into northern Western Australia (WA) for the control of cattle tick. In view of the bird's history in the eastern states, however, and the likelihood of their spreading to all parts of WA, the project was dropped (Jenkins 1959).

In the 1880s starlings were released near Adelaide, South Australia (SA), from where they spread rapidly and were established on Eyre Peninsula by 1900 (Long 1981). By 1950 starlings had spread westwards (as well as northwards) and had reached the limits to agriculture in SA. Between 1951 and 1976 further westerly spread occurred (Blakers *et al* 1984) over pastoral land and numbers had entered and had bred in WA. (See below).

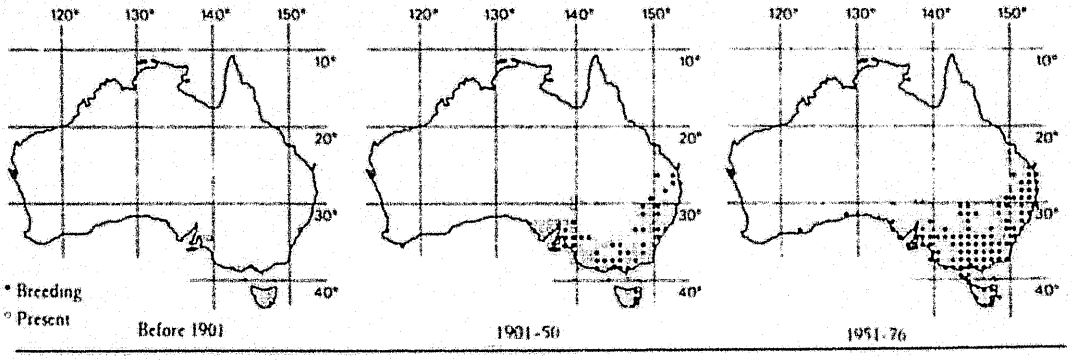


Figure 1. Historical Map
(Blakers *et al* 1984)

The starling is a declared species under the Agriculture and Related Resources Protection Act, 1976. The declaration prohibits the keeping or the importation of starlings into WA. Introductions of exotic species of birds throughout Australia has declined since Acclimatisation Societies were at their zenith during the latter part of the nineteenth century. However unwelcome introductions have occurred much later. The common myna (*Acridotheres tristis*) was aided in its colonisation of Canberra with releases between 1968 and 1971 (Canberra Bird Notes, July 1985, p 97). The declaration of the starling in WA and some other exotic species precludes legitimate releases of unwanted species in WA. The misguided release of common mynas into Canberra should not be repeated. The common myna is also a declared species in WA, a bird that cannot be legally kept or imported into WA. Species are declared when their establishment would be likely to cause losses to agriculture or related resources.

Likelihood of Establishment in WA

Individual starlings have been recorded in widely spaced parts of WA as well as the south coast incursion of a flock to nearly reach Albany. Advice from WA Museum staff suggested that starlings could turn up anywhere in WA (G Storr, pers. comm., 1985). This advice has been confirmed by the aforementioned vagrant records. J Long (pers. comm., 1991) confirmed that starlings were certain to become established in the south-west of the state if they were left to their own devices. The WA Museum (G Storr, pers. comm.) and the Department of Conservation and Land Management (CALM) (D Mell, pers. comm.) have advocated that the eradication program continue, supporting the concept that starlings would be well suited and would proliferate in the south-west.

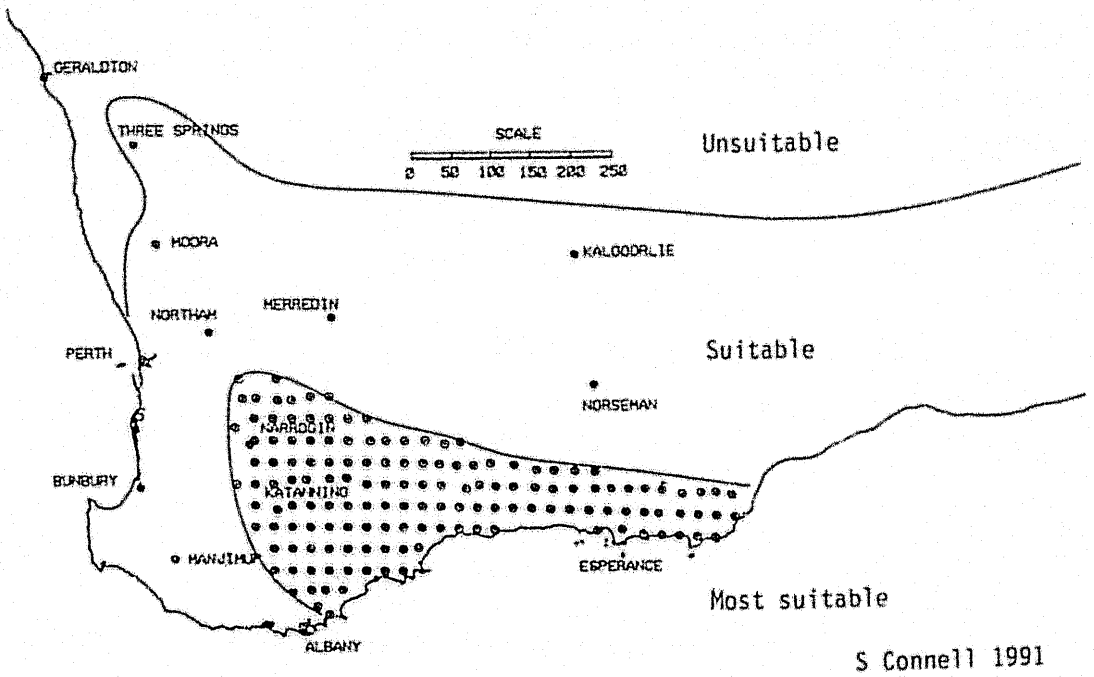
The main establishment of the starling in WA would probably proceed along the coast, south of the Nullarbor Plain through to Esperance. Incursions there have survived where nitre bushes or native grape (*Nitraria schoberii*), invertebrates in seaweed and insects in open areas have provided all the essentials for establishment. Spread in a northerly direction would certainly occur, but probably later than the westerly thrust. A further build up in numbers would take place over many years following the initial establishment.

Without an eradication campaign starlings would probably take 5 to 10 years to become well established in the Esperance area, another 5 to 10 years to infiltrate the south-west in reasonable numbers and a further 5 to 10 years to make a significant impact on the Perth metropolitan area. In summary it could be assumed that following the cessation of a starling eradication program starlings would reach Perth and be throughout the south-west within 15 to 30 years.

A climate-based prediction was developed, from the distribution in the eastern states and related back to WA by Dr Connell (Research Officer, Western Australian Department of Agriculture). That prediction suggested starlings would be most suited in an area along the south coast from Cape Arid, east of Esperance to Albany and ranging in a triangular shape to Narrogin (see Figure 2). An area to the north and west was also likely to harbour starlings but not to the same degree. North from the second area was predicted to be likely to support a smaller starling population. This climate-based prediction needs to be qualified. Provision of pastures for feed, availability of tree holes and other nesting sites and easily accessible fresh water would ensure that the south-west of WA was ideal for starlings and would be better suited than either the Narrogin or Katanning areas (P Mawson and M Massam, pers. comm., 1991).

Figure 2

POTENTIAL DISTRIBUTION OF STARLINGS IN SOUTH WESTERN AUSTRALIA



The Agriculture Protection Board's Starling Eradication Campaign

Small numbers of starlings had been periodically killed in sporadic ventures by the Agriculture Protection Board of WA (APB) to the Nullarbor in the 1960s and then during the 1970s a starling eradication team was established at Eucla to attempt to keep WA free from starlings. Varying numbers were employed on starling eradication but an average of three officers were fully occupied on starlings until about 1983 when the control team was doubled. Extra assistance from elsewhere within the APB was often allocated to starling control when the need arose. Since about 1987, with starling incursions into the agricultural areas, APB District Officer staff time was allocated to starling control. For Esperance this activity went back as far as 1972. At present about twenty starlings are located east of Esperance but none elsewhere. The Eucla starling control team is presently back to four people from a maximum of six in the mid 1980s.

Starling Eradication Costs, 1991/92 from the Agriculture Protection Board

Staff costs	$285,000
Plus research and corporate services loading	$91,000
(32% of the APB'S 1991/92 budget was research and corporate services)	
Total	$376,000

Unless the present eradication campaign was maintained by another Government instrumentality, for example CALM or the Department of Environmental Protection, there would be very little possibility of a private organisation for example Royal Australasian Ornithologists Union (RAOU), WA Naturalists or individual members of the public mounting a successful eradication campaign. The mobility of the birds and their elusive nest building habits would count against farmers keeping their properties free from starlings. Although the RAOU, through the Eyre Bird Observatory, does undertake some control measures, through trapping, neither the WA Naturalists nor the RAOU have the monetary resources to co-ordinate a control program that would be necessary for starlings.

Value of the Eradication Campaign

If established in WA starlings would cause damage and costs to the community in three specific areas. This damage and cost to WA would be similar to that experienced in the eastern states and in other parts of the world. It has been said that starlings in the eastern states do not cause extensive damage but are a minor nuisance and if established in WA the annual costs attributed to starlings could be less than the cost of the control program (J Long, pers. comm., 1991). Unfortunately no data is available to verify or otherwise Mr Long's statement. Detailed analyses on the starlings suitability to Western Australian conditions and propensity to proliferate, as has happened in California, would be required to evaluate the extent of damage expected if establishment occurred. Californian conditions may be more closely related to Western Australian conditions than the eastern states of Australia.

The three areas where damage could occur would be in agriculture, in built-up areas and also with the natural environment. In agriculture starlings have reduced yields in the soft fruits industries, principally grapes by approximately 10 per cent. Some individual grape growers may incur higher losses but generally the loss to the industry would be lower than 10% (M McCarthy, pers. comm., South Australia, 1991). Other soft fruits would also be susceptible, e.g. apples and pears, but damage to cherries, that are subject to damage in Europe need not be considered as they do not produce very well in WA. Experience in Tasmania indicates that some fruit netting is advisable.

As a result of starling damage Tasmanian growers of vines, cherries and blueberries have resorted to protective netting. Without netting vineyards could lose $2,500 per hectare and cherry orchards $40,000 per hectare. Netting of vineyards is approximately $4,000 per hectare and lasts four to five years. A permanent structure for cherries costs approximately $13,000 for materials and $16,000 for labour per hectare (M Statham, pers. comm., Tas, 1992).

Damage to broad acre cereal production would be expected to be minimal. Any minor damage would be likely to be offset by the invertebrates consumed. Starlings have been recorded stealing grain, contaminating feed-lots in the US (Weber, 1979) and in the UK (Feare and Swannack, 1978). However in WA the bird proofing of susceptible areas could ameliorate situations where feed losses were occurring e.g. dairies. Feed lotting of stock is not an extensive industry in WA. A potential problem lies with the poultry industry. Newcastle disease virus (NDV) is absent from Australia but if NDV became established migrating starlings could possibly aggravate further spread to poultry farms. NDV has been identified from migrating starlings, wintering in Israel (Lipkind *et al*, 1987) and also from starlings in California (Pearson and McCann, 1975).

In an urban environment starlings have built up into large numbers, roosts of many thousands (including tens of thousands) have been seen across Australia. The noise and faecal droppings from large roosts cause a nuisance to the people inhabiting the area. Birds nesting in gutters have the capacity to spread diseases to man including a lung ailment, histoplasmosis. The hazards from birds nesting in and on roofs and gutters would increase substantially if starlings became prevalent in Perth.

Gutter guards and boxing of eaves would be necessary additions to some houses and other areas, particularly in older buildings, would require more intricate and expensive methods to deter starlings from roosting and nesting. In corrugated iron roofed houses near Ballarat, metal strips are required to block off the holes at the corrugations to keep starlings from roof cavities (R Elshaw, pers. comm., 1991). In susceptible areas some domestic housing would require approx. $1,400 to install bird protection measures. This is based on a commercial quote to starling (bird) proof a Canberra house roof at $50/m of house perimeter (M Lintermans, pers. comm., ACT, 1992).

Hector's Break-Even Analyses Discussed

Hector (1989) produced a set of break-even analyses for WA calculating the extent of damage necessary to pay for the present control program. Each of Hector's seven sections will be discussed. Hector's break-even figure of the damage to the industry necessary to match the amount spent on starling control is in brackets for each industry. Hector's complete break-even analyses are included in Appendix 3.

1. **The pome, soft fruit and grape industries (0.470% damage necessary to cover the starling eradication campaign)**

   In Hector's calculation 0.470% damage to the above industries was required to be equivalent to the cost of the control program $220,000.

   Discussion: The grape industry was probably most susceptible and a 5% loss could be expected to occur. This damage to grape production would be approximately $550,000. If a 5% loss occurred to the remaining susceptible fruit sectors i.e. soft fruits (but excluding mangoes) the value lost would be 0.05 x $8,348,000 i.e. $420,000 and pome fruit $1.1 m. Therefore the expected losses to the fruit industry would be approximately $2.1 m pa.

2. **The grain industry (0.028% damage necessary)**

   Hector questioned whether there would be any loss to the grain industry and that doubt would be concurred by the author.

   Discussion: No measurable loss to the cereal industry would be expected to occur. In England damage to germinating winter cereals occurs mainly close to roosts when large numbers of starlings may feed briefly on fields in pre-roost assemblies. Although plant densities may be considerably reduced, recent work has failed to show a significant effect on crop yield (Feare, 1990).

3. **The pig industry (0.426% damage necessary)**

Hector outlined that transmission of disease was not appropriate at present as the disease most likely to be transported from piggery to piggery was absent in WA but could occur in the future.

Discussion: Piggeries would need to be bird proofed or losses to feed would be expected. Bird proofing would be necessary where not already in place to exclude either pigeons, swallows or galahs. The costs associated with extra bird proofing necessary for starlings is not likely to be substantial and will be excluded from this calculation.

4. **The cattle industry (0.125% damage necessary)**

Paddock cattle may be affected by starlings defecating on their backs but damage may not be measurable and could be excluded. Figures for anticipated losses to the lot feeding industry have not been calculated as they may be low. Bird proofing of dairies would be similar to the pig industry and will be excluded.

5. **The sheep and wool industries (0.018% wool industry, 0.138% sheep industry damage necessary)**

The main losses to sheep involve starlings alighting on the backs of sheep and causing skin damage by pecking or by defecating and attracting a blow fly strike.

Discussion: This is an infrequent occurrence as reports of this matter have not been identified by the author. Any damage could be offset by improvements in pasture growth caused by starlings taking out insect pests.

6. **The natural environment (2.75% damage necessary)**

Hector reported that De Graaf and Payne (1975) valued non-game birds in the US at $US1.7 billion, or almost $US7 per person. Hector (1989) converted that to $A8.9.

Discussion: The approximately $A9 per person in WA was discounted as Australian conservationists may not have reached the same degree of philanthropy as apparent in the US with "save the burro" schemes that have proved to be quite expensive. Some people have been prepared to spend $US1500 to save a burro from destruction. Assuming a population of 1.6 million people and a 33% discount for WA (to be more conservative than the US) for the value of non-game birds, the net result would be that non-game birds were worth about $10 million. If there were 50 million non-game birds in WA then on average each bird would be worth about 20c. Without a discount for Australians being more conservayive than people in the US the value of non-game birds would increase to about 30 cents.

The establishment of starlings in the southern half of WA would be likely to effect tree hole nesting native species, e.g. some parrots as well as tree creepers, thornbills and wood swallows (Massam, 1990). Starlings take over nesting sites by persistently disturbing any occupants and would be expected to seriously affect an already diminished natural resource, indigenous trees with suitable nesting holes. Notwithstanding a specific effect on parrots a general reduction of 5% to 10% in the native bird population of WA could be translated into a loss of $750,000 (7½%). This is an extremely rudimentary calculation and may be an underestimate.

7. **The urban environment (5.5% damage necessary)**

Hector (1989) estimated that the public cleaning cost in the metropolitan area was approximately $4m pa.

Discussion: However added to the public cleaning costs were the extra costs associated with houses that may need to close off eaves or install guards to preclude nesting starlings. Gutter guards would probably be necessary in some instances. Individual houses may be involved in an outlay of $1,400 to deter starlings. Many houses may be bird-proofed for much less. If two per cent of the approximately 200,000 urban houses in southern WA were affected the total cost to private dwellings would be approximately $5.6m. A five per cent increase in metropolitan public cleaning costs could also be affected adding a further $200,000. An estimate of cost to the urban environment and to where people reside in houses could be $5.8m.

Summary of Cost Estimates if Starlings Established in WA used in this Analysis

1.	The fruit industries	$2.1m
2.	The grain industries	$0
3.	The stock industries	$0
4.	The natural environment	$750,000
5.	The urban environment	$5.8m
Total approx.		$8,650,000

Cost-Benefit Analysis Over Fifty Years

The calculation above gives a snapshot of the costs of control and the benefits of not having starlings in WA. To predict the value of the program over a period of time a spreadsheet was developed to calculate benefits and costs over a planning period.

A number of assumptions have been built into the spreadsheet (see Table page 8). The "Estimated Benefit" has been divided into three sections; agriculture, the natural environment and the urban environment (suburbia). Each of the three figures can be altered and the spreadsheet completes the calculation. The spreadsheet allows variations in any of the key parameters to be made producing various results. The "Estimated Cost" combines the actual costs of the starling eradication campaign plus a research and corporate services loading. These costs can be escalated by a given percentage per annum. (See Table page 7).

Over the planning period, the benefits will be relating to both a bigger suburban component as well as an increased agricultural production. For example the gross value of WA's grape industry has increased by over 250% from 1980/81 to 1990/91 (i.e.. $3.046 m to $10.926 m, ABS). Fruit generally has increased in value of production by approximately 70% from 1980/81 to 1990/91 (i.e.. $36.7 m to $62.6 m, ABS). An annual increase of 5.5% is equivalent to approximately 70% over ten years.

The human population is expected to increase by approximately 2 per cent per annum over the next forty years (ABS, 1989). This can be extended to the planning period (up to 50 years) for this calculation. This population increase will increase both the value of the environment and suburbs when starlings continue to be absent.

Consequently the base figures for agriculture will be escalated by 5.5 per cent per annum and for the environment and suburbia by 2 per cent per annum.

The planning period sets the number of years over which the cost benefit analysis is calculated. It was set to cover a significant period (50 years) as there would be a lag from the time the control program ceased to the time starlings commenced to inflict measurable damage. That lag was estimated to be approximately ten years. The year at which maximum damage occurred takes into account the time necessary for the starlings to build-up to their maximum population level and hence cause the maximum amount of damage. The whole calculation is set in 1991/92 dollars by applying a five per cent discount rate.

Conclusion

The results are taken from the calculations detailed in Appendix 1. The cumulative net benefit for the starling eradication campaign, over fifty years, is approximately $140 million. The break-even year for the eradication campaign, or the time it would take before starlings would cause net losses to WA if the campaign was curtailed, would be fifteen years. The benefit/cost ratio would be about 18:1. The starling eradication campaign, primarily based on the Nullarbor but also augmented by activity at Esperance, is soundly based on economic criteria and should be continued to keep WA free from this particular bird pest.

Acknowledgements

Thanks go to Mrs Jo Pluske (formerly Ms Jo Hector, APB) who initiated the analysis of the starling eradication campaign and to the Policy Analysis and Industry Development Division of the Department of Agriculture, Western Australia, in particular Messrs Andrew Bathgate and Ian Wilkinson who assisted with the modelling. Thanks also go to Mr Greg Pickles who commented on the draft and to Mr Jeremy Dixon who designed the cover.

Table: Cost benefit analysis assumptions and results

Starling Control in Western Australia:
A Cost-Benefit Analysis

Estimated Benefit		Increase /year
Agriculture	2,100,000	5.5%
Environment	750,000	2.0%
Suburbia	5,800,000	2.0%
Total	8,650,000	

Assumption 1: starling damage is linear from any year x to year x plus 20
Assumption 2: lag period before damage is recorded equals year x
Assumption 3: year at which maximum damage reached is year x plus 20

Estimated cost	
Starling control costs 1991-92	376,000
Cost increase	.010
Planning period (<50 years)	50
Discount rate	.050
Lag period before damage is recorded	10
Year at which maximum damage reached	30

Results	
Linear growth in damage	
Net Present Value	$143,603,050
Benefit Cost Ratio	18.8
Break even year	15

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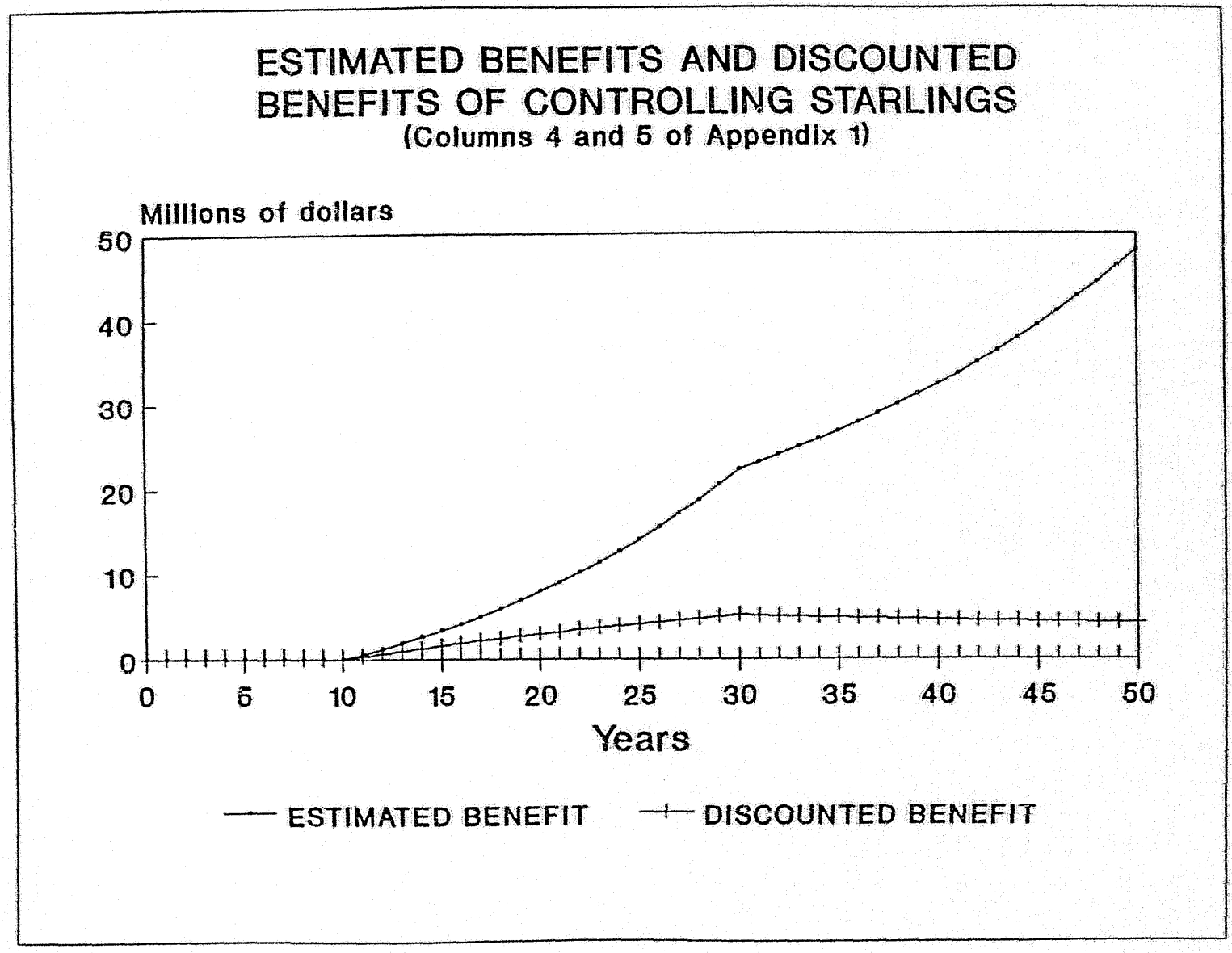
STARLING CONTROL

APPENDIX 1: Cost benefit analysis calculation spreadsheet.

Year	APB Costs Incurred to Control Starlings	Discounted Costs	Estimated Benefits to WA With no Starlings	Discounted Benefit	Annual Net Benefit	Cumulative Benefit
1	376,000	358,095	0	0	(358,095)	(358,095)
2	379,760	344,454	0	0	(344,454)	(702,549)
3	383,558	331,331	0	0	(331,331)	(1,033,880)
4	387,393	318,709	0	0	(318,709)	(1,352,590)
5	391,267	306,568	0	0	(306,568)	(1,659,158)
6	395,180	294,889	0	0	(294,889)	(1,954,047)
7	399,132	283,655	0	0	(283,655)	(2,237,702)
8	403,123	272,849	0	0	(272,849)	(2,510,552)
9	407,154	262,455	0	0	(262,455)	(2,773,007)
10	411,226	252,457	0	0	(252,457)	(3,025,464)
11	415,338	242,839	596,425	348,717	105,878	(2,919,586)
12	419,491	233,588	1,229,952	684,883	451,295	(2,468,291)
13	423,686	224,690	1,902,787	1,009,089	784,399	(1,683,892)
14	427,923	216,130	2,617,276	1,321,902	1,105,772	(578,120)
15	432,202	207,897	3,375,910	1,623,870	1,415,974	837,853
16	436,524	199,977	4,181,339	1,915,520	1,715,543	2,553,396
17	440,890	192,359	5,036,383	2,197,357	2,004,999	4,558,395
18	445,298	185,031	5,944,037	2,469,870	2,284,839	6,843,234
19	449,751	177,982	6,907,487	2,733,527	2,555,545	9,398,779
20	454,249	171,202	7,930,123	2,988,780	2,817,578	12,216,358
21	458,791	164,680	9,015,548	3,236,062	3,071,383	15,287,740
22	463,379	158,406	10,167,597	3,475,792	3,317,385	18,605,126
23	468,013	152,372	11,390,346	3,708,370	3,555,998	22,161,124
24	472,693	146,567	12,688,132	3,934,183	3,787,616	25,948,739
25	477,420	140,984	14,065,570	4,153,602	4,012,618	29,961,358
26	482,194	135,613	15,527,568	4,366,985	4,231,372	34,192,729
27	487,016	130,447	17,079,346	4,574,674	4,444,228	38,636,957
28	491,887	125,477	18,726,461	4,777,001	4,651,524	43,288,481
29	496,805	120,697	20,474,822	4,974,283	4,853,586	48,142,067
30	501,773	116,099	22,330,716	5,166,824	5,050,725	53,192,792
31	506,791	111,676	23,143,651	5,099,923	4,988,247	58,181,038
32	511,859	107,422	23,992,992	5,035,317	4,927,895	63,108,933
33	516,978	103,330	24,880,576	4,972,944	4,869,614	67,978,548
34	522,147	99,393	25,808,336	4,912,741	4,813,347	72,791,895
35	527,369	95,607	26,778,309	4,854,647	4,759,040	77,550,935
36	532,643	91,965	27,792,641	4,798,606	4,706,641	82,257,576
37	537,969	88,461	28,853,593	4,744,559	4,656,097	86,913,674
38	543,349	85,091	29,963,543	4,692,452	4,607,360	91,521,034
39	548,782	81,850	31,125,001	4,642,231	4,560,381	96,081,415
40	554,270	78,732	32,340,608	4,593,844	4,515,112	100,596,527
41	559,813	75,732	33,613,149	4,547,241	4,471,508	105,068,035
42	565,411	72,847	34,945,555	4,502,372	4,429,525	109,497,560
43	571,065	70,072	36,340,917	4,459,190	4,389,118	113,886,678
44	576,776	67,403	37,802,491	4,417,650	4,350,247	118,236,925
45	582,543	64,835	39,333,709	4,377,704	4,312,869	122,549,794
46	588,369	62,365	40,938,185	4,339,311	4,276,946	126,826,741
47	594,253	59,989	42,619,729	4,302,428	4,242,439	131,069,179
48	600,195	57,704	44,382,357	4,267,013	4,209,309	135,278,489
49	606,197	55,506	46,230,301	4,233,027	4,177,522	139,456,010
50	612,259	53,391	48,168,020	4,200,431	4,147,040	143,603,050


ESTIMATED BENEFITS AND DISCOUNTED BENEFITS OF CONTROLLING STARLINGS
(Columns 4 and 5 of Appendix 1)
Millions of dollars
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
50
Years
ESTIMATED BENEFIT
DISCOUNTED BENEFIT

APPENDIX 3: Break-Even Analyses from "An Economic Analysis of Potential Starling Damage in Western Australia by JM Hector, Agriculture Protection Board of WA, Discussion Paper 3, December, 1989

5. BREAK-EVEN ANALYSES

As mentioned in section 3.4, starlings are capable of causing damage and disease which affects agriculture, the environment and people. Evaluating the costs and benefits of starlings and their control in Western Australia would involve many unqualified assumptions and perhaps would produce questionable results. The analyses in this project consisted of finding the value of starling damage as a percentage of the gross value of a particular resource.

The latest ABS figures refer to the year, 1987/88 (ABS, 1989), so all figures quoted in the following analyses will be of the same year. The value of starling damage was assumed to be equivalent to the cost of the APB starling programme, that is $220 000 in 1987/88.

From the results, "break-even" points could be calculated. That is, the percentage change in value of an resource, due to starling damage, which would have to occur to be equivalent to the cost of the APB starling programme. It is beyond the scope of this project to proportion the total damage starlings would be capable of achieving in Western Australia into the various resources. Therefore, the results illustrate the value of damage to a particular resource, equivalent to the value of the APB starling programme.

5.1 The Pome, Soft Fruit and Grape Industries

Value of the Fruit Industry - $46 805 000

$220 000 / $46 805 000 x 100 = 0.470%

That is, starlings would have to inflict damage that would cause the gross value of fruit (susceptible to potential starling damage) in Western Australia to decrease by around 0.5% to cover the cost of the APB's starling programme.

5.2 The Grain Industry

Value of the Grain Industry - $789 060 000

$220 000 / $789 060 000 x 100 = 0.028%

It is questionable whether starlings would attack grain crops in Western Australia and if they did whether they would reduce yield. If they were to have an effect on yield, a reduction (attributable to starlings) of only 0.03% of the gross value of grain produced in this state would cover the cost of the APB's programme.

5.3 The Pig Industry

Value of the Pig Industry - $51 694 000

$220 000 / $51 694 000 x 100 = 0.426%

The disease TGE which is of concern in the pig industry has not yet reached Western Australia. However starlings also eat and contaminate pig food. This may cause pigs to grow at a reduced rate due to a decrease in available food. If this was the case, starlings would have to reduce the gross value of the pig industry by 0.4% for the cost to equal that of the APB's control programme.

5.4 The Cattle Industry

Value of the Cattle Industry - $176 033 000

$220 000 / $176 033 000 x 100 = 0.125%

Feed from feedlots in Western Australia may be stolen and contaminated by starlings. Starlings also peck insects from the backs of cattle and can cause lesions which may become infected or flystruck. Supposing these birds decreased the gross value of the cattle industry by around 0.1%, this cost would be equivalent to that of the APB's programme.

5.5 The Sheep and Wool Industries

Value of the Sheep Industry - $159 177 000

$220 000 / $159 177 000 x 100 = 0.138%

Value of the Wool Industry - $1 252 674 000

$220 000 / $1 252 674 000 x 100 = 0.018%

Starlings may cause flysrike in sheep by also causing lesions as well as defecating on sheep's backs and thus attracting flies. The stains from the droppings may also degrade the quality of the wool. These birds may eat supplementary grain given to sheep which could affect body growth and condition and subsequently wool production. Starlings would have to cause damage to the value of around 0.1% of the gross value of the sheep industry or 0.02% of the value of the wool industry to cover the cost of the APB's programme.

5.6 The Environment

Starlings are reported to affect many aspects of the environment, however data to quantify this value is scarce. From De Graaf and Payne (1975) the value of non-game birds in the United States was US$1,700 million or almost $7 per person. Converting to Australian dollars, this is around $8.90 per person in Western Australia. There are approximately 1.5 million people in the state so the total value of non-game birds maybe around $13 million.

$220 000 / $13 000 000 x 100 = 1.70%

If Western Australians do value native non-game birds in the same way as Americans then starlings would only have to decrease the number of birds in this state to the value of about 2% of the preservation value before the APB's program would be worth while.

5.7 The Urban Environment

In urban centres starlings create physical, noise and air pollution, deface and damage buildings and sidewalks and may cause fire hazards by building their nests in strategic places (Weber, 1979). The cost of this damage would be extensive and may constitute a project within itself. However, in an attempt to estimate part of this cost, the cost of public cleaning was sought with the held of Mr Landhams form the City of Melville. By extrapolating data, the public cleaning cost for the total Perth Metropolitan area could be approximately $4 million per year.

$200 000 / $4 000 000 x 100 = 5.5%

If the method of cleaning was not altered and cost the same with or without starlings, the cost of public cleaning in the presence of starlings would only have to rise by around 5% before the APB's program could be justified.