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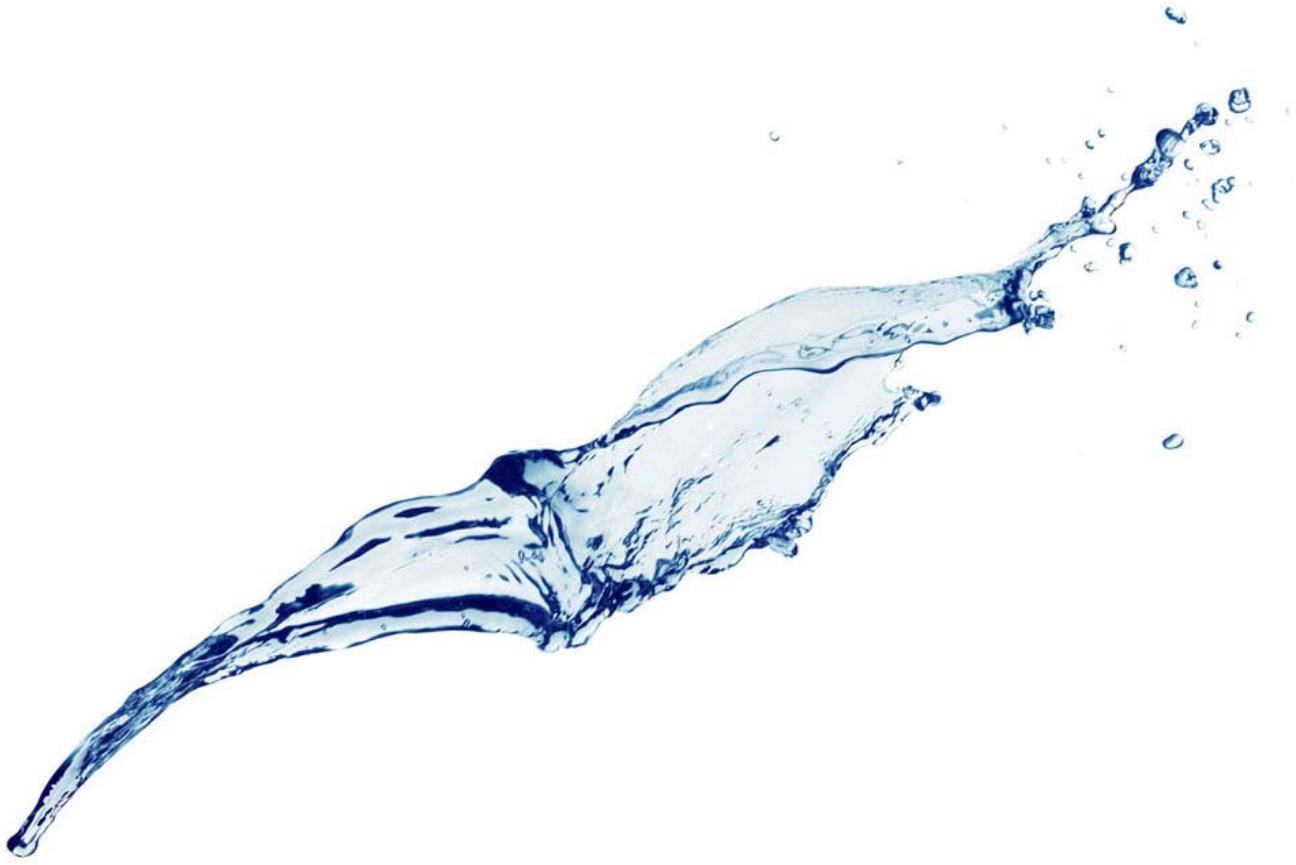
MAF - Styela clava:
Economic Impact Assessment



August 2011

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1. Executive Summary

This report presents the findings of a review of the predicted and current economic impact of Styela clava in New Zealand. This research was carried out by Deloitte in conjunction with NZIER to refresh the economic impact analysis of Styela carried out by NZIER in 2005.

The estimated impact of Styela between 2006 and 2011 is between $0.1 million and $9.4 million. The earlier assessment estimated impacts over that time to be between $0.1 million and $110.0 million. The low level of impacts is due in part to Styela failing to spread to the high value regions of Marlborough and Tasman-Nelson. In addition, the share of affected oysters out of total oyster production is now significantly lower than the share included in the 2005 estimate.

Most of the expected economic damage between 2011 and 2020 from Styela is felt most in Auckland and Waikato, where it is already established. Marlborough is also expected to be significantly impacted, as it is a high-value region for aquaculture. The mussel industry suffers most from Styela.

Sensitivity analysis examined the impact of reducing the spread of these pests. Already, actual damage is lower because Styela has not reached the Marlborough, Nelson, and Tasman regions. By delaying the entry of Styela to Marlborough, the impacts are estimated to reduce by between $1.6 million and $53.5 million. Slowing the spread of Styela from 14 years to 20 years could reduce the national impacts by between $21.1 million and $80.4 million.

These reduced impacts could be used as a cost guide for any government intervention that would delay these pests from spreading to other regions, or slowing the rate of spread within a region.

During this work, we did not include all potential sources of economic losses, due to data limitations. For example we did not include any estimates of the impacts on spiritual or cultural values, or the effects of these pests on human health.

For most of these other effects the economic impacts are likely to be negative, although relatively small.

2. Introduction

The purpose of this report is to update the 2005 NZIER report to determine the current economic impact of Styela clava, and to extend the assessment to include the economic impacts of other freshwater pest plants.

In carrying out this work, Deloitte partnered with NZIER. This allowed us to use the same model as in the 2006 didymo research with updated figures, thereby ensuring comparability of the results.

2.1. Styela clava

Styela clava (Styela) is a saltwater pest that was first detected in Auckland in September 2005, and was subsequently found throughout the Hauraki Gulf and Lyttleton port. Since then it has been found in Waikawa marina, Wellington harbour, port of Nelson, Marsden Cove marina, Opua marina, Tutukaka marina, and Otago harbour. Of these locations, Styela has only become established in Marsden Cove and Opua marinas[1].

Styela is expected to impact mainly on commercial aquaculture and local biodiversity. This is because it competes for both food and physical space with existing species. It is also recognised as a significant fouling pest on ships' hulls.

In this section we briefly review NZIER's previous economic impact assessment, compare the estimated impacts with the actual impacts between 2006-2010, and then update the economic impact assessment for 2011-2020.

2.2. Data Gathering Methodology

The methodology used to collect the data which informs the economic analyses involved four steps:

1. Identifying participants
2. Distribution of surveys
3. Survey returns and collating
4. Follow-up phone interviews

Identification of participants was carried out in conjunction with MAF, and included identifying contacts within regional authorities as well as industry contacts from power companies, industry groups, and recreational organisations.

[1] MAF Biosecurity New Zealand, *Sea Squirt (clubbed Tunicate),* available at: [http://www.biosecurity.govt.nz/pests/seasquirt]

The survey was designed in conjunction with MAF staff to ensure the right information was captured and that it was understandable for the participants. We delivered the survey as an excel spreadsheet and captured data according to the following subsections:

Infestation

Infestation data was targeted at understanding the degree of infestation of a given pest in a given region, the severity of the infestation, and the expected severity if the pest goes unchecked over the next decade. The specific data points for this section of the survey were as follows:

- Species type
- Location (region)
- Time since infestation
- Current severity (high/med/low)
- Expected severity in 10 years (high/med/low)

Management Programmes

This section gathered information on previous management programmes, programmes currently underway, and any planned future programmes. The purpose of this section was to gather financial and impact data on pest management programmes, and also to understand the degree of public/private funding for these programmes. The specific data points for this section of the survey were:

Previous Programmes

- Programme Name
- Cost Of programme
- Impact on infestation level

Current and Future Programmes

- Programme Name
- Purpose
- Commencement Data
- Funding structure
- Contribution value
- Contribution type (in-kind, monetary)

- Effectiveness
- Performance measures

Impacts

The impacts were divided into categories: commercial, social, public health, and cultural/environmental. Within each of these categories a range of relevant impacts could be described by the participants.

Commercial Impacts

The commercial impacts were described in terms of the change in output levels, output quality, and/or production losses. These impacts were described across the following commercial activities:

Fishing	Wild Stocks
	Eel Fisheries
	Salmon fisheries
	Other fisheries
Aquaculture	Mussels
	Oysters
	Other marine farming
Tourism	Jet-boating
	Kayaking
	Diving
	Other tourism
Municipal, industrial, and agricultural water intakes	
Boats and shipping	
Ports and harbour operations	
Other commercial impacts	

Social Impacts

Social Impacts were largely described in terms of impact on recreation values across the following activities:

- Fishing
- Jet-boating
- Kayaking

- Diving
- Swimming
- Other Recreation

Public Health

Public health impacts were focussed on the impact of the pest on commercial or municipal drinking water, with space given to other general public health impacts. The key variables collected were

- Impact on disease rates
- Impact on personal injury rates
- Impact on prevention costs

Cultural & Environmental

There was a very wide range of potential questions relating to cultural and environmental impacts of pest incursions. We elected to keep these questions open to allow participants to describe the impacts rather than being overly structured in this aspect of data capture. The impact areas covered were:

- Native species
- Rivers
- National Marine reserves
- Other cultural or environmental impacts

We have provided MAF with a copy of the survey template so that all the data fields and overall capture schema may be revised and reused in subsequent survey updates.

Surveys were completed by participants and emailed back to Deloitte where the data was stored and collated. After carrying out a gap analysis to identify sections with missing information, we made a series of follow up phone-calls to gather and fine-tune our data.

3. Summary of previous assessment

In 2005, NZIER reviewed the likely economic impacts of Styela, described a model that could be used to estimate the monetary of those impacts in the key aquaculture regions of New Zealand, and produced some preliminary results from that model. The results were presented as the present value of the impacts across 21 years from 2005 to 2025.

The previous assessment focussed on shellfish farming and associated processing industries. As its review concluded those industries are where the major economic impacts are likely to be felt, specifically the model centred on mussel and sub-tidal Pacific oyster production. The model included five key variables:

- The reduction in output caused by Styela infestation of marine farms
- The increased costs faced by marine farms and processing in dealing with the presence of Styela
- The timing with which Styela arrives in particular regions
- The rate of spread of Styela within a region after arrival
- The distribution of mussel and oyster production across the regions and their future growth in the absence of Styela.

The preliminary results of that modelling included a range of scenarios that reflected the lack of information about the expected impacts of Styela on output and production costs, its expected time of arrival in each region, and the speed with which it spreads through a region. The scenarios included:

- Low, medium, and high impact scenarios where output and production costs are negatively impacted by 5 percent, 20 percent, and 35 percent, respectively.
- Regional arrival dates of 2005 for Auckland and Waikato, 2006 for Northland, 2007 for Marlborough, Tasman-Nelson, and Southland.
- Four scenarios where, following arrival in a region, Styela spreads throughout the region in 2, 8, 14, and 20 years.

Table 1 shows some of the preliminary results from the previous assessment. It shows that, over the 21 year period, the impacts of Styela on the shellfish industry in Auckland and Waikato could range from $13.7 million to $68.2 million. If Styela was to spread to Marlborough, Tasman, and Nelson in 2007, then the impacts on the national shellfish industry could triple to range from $46.2 million to $239.8 million.

Table 1 Results from previous Styela Economic Impact Assessment

Present value of impacts 2005-2025, millions of New Zealand dollars

		20 Year Full Regional Spread			14 Year Full Regional Spread		
Impact Scenario		**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
Output		5%	5%	20%	5%	5%	20%
Costs		5%	20%	20%	5%	20%	20%
PV Loss	**Discovery year**	**$m**	**$m**	**$m**	**$m**	**$m**	**$m**
Auckland/Waikato	2005	13.7	32.4	51.4	18.2	43.1	68.2
Northland	2006	0.5	1.1	1.8	0.7	1.5	2.5
Marlborough	2007	13.7	34.0	51.3	19.3	47.7	71.9
Tasman/Nelson	2007	18.0	37.9	68.3	25.3	53.1	95.8
Southland	2007	0.3	0.7	1.1	0.4	0.9	1.4
Total sector impacts		**46.2**	**106.1**	**173.9**	**63.9**	**146.3**	**239.8**

Source: NZIER (2005)

While these results were based on a set of assumed timings around the arrival and spread of Styela within a region, the model does highlight the benefits of delaying the spread of Styela to other regions. The assessment showed that by delaying the arrival of Styela in the Tasman/Nelson region by five years, the present value of the impacts would reduce from between $10.3 million and $44.0 million, based on the scenarios presented in Table 6. The previous assessment suggested that these benefits could be used to assess the cost that could be incurred to reduce the probability of Styela's spread.

Not all of the potential impacts of Styela were included in the previous assessment due to a lack of available data. These other potential impacts included:

- Recreational and tourism activities (such as diving)
- Other small aquaculture and fishing activities
- Social and cultural impacts, such as the change in the biodiversity of the aquatic environment.

4. Impact Assessment Refresh

4.1. Approach

This update followed the same methodology as was used in the previous assessment. We make use of more recent forecasts of the Aquaculture industry, as provided by Aquaculture New Zealand.

Table 2 briefly outlines the main differences in approach between the two assessments, with full details of the methodology provided in Appendix I.

Table 2 Differences in approach between 2005 assessment and 2011 update

	2005 assessment	2011 update
Baseline scenario	**Revenue** Aquaculture forecasts 2004 – 2025 (New Zealand Aquaculture Council, 2005) **Intermediate costs** Philip Donnelly & Associates (1999) estimate economic value add of mussel industry to be 55 percent of revenues. This implies intermediate costs to be 45 percent of revenues	**Revenue** Aquaculture forecasts 2008 – 2025 (Aquaculture New Zealand (2009) **Intermediate costs** Same as 2005
Range of impacts	Low, medium, high impact scenarios of both impacts on output and on costs.	Same as 2005
Distribution	Modelled as first located in Auckland/Waikato in 2005, Northland 2006, and other regions in 2007.	Modelled as first located in Auckland/Waikato in 2005, Northland 2006, and other regions in 2013.
Rate of spread	Scenarios ranging between full spread within a region in 2, 8, 14, and 20 years	Same as 2005

Source:NZIER

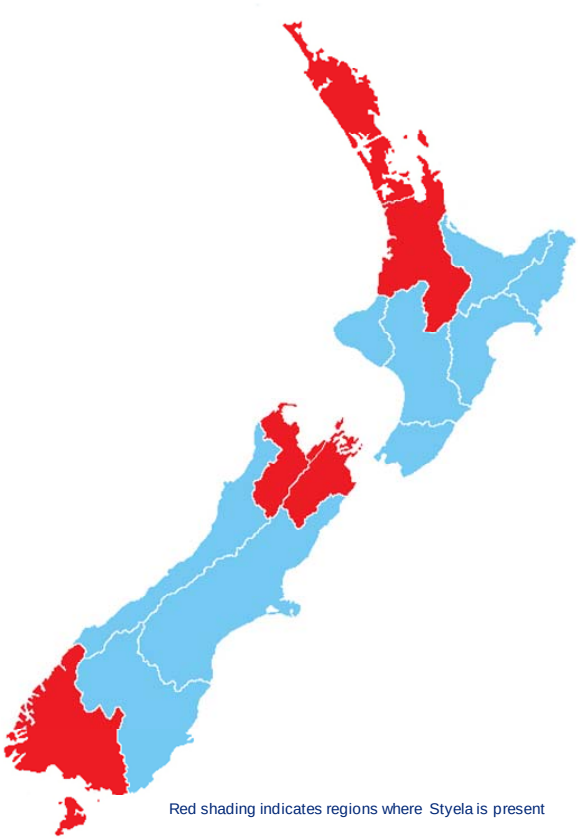
4.2. Estimated actual impacts 2006-2010

The previous economic impact assessment was completed in 2005. In this section we estimate the actual impacts of Styela between 2006 and 2010.

Information on the impact and spread of Styela within regions since 2005 remain scarce. MAF Biosecurity New Zealand state that, as of June 2009, Styela has become established in Auckland, Waikato, Northland, and Canterbury[2]. The Canterbury Styela population is established in Lyttelton harbour and not the high value shellfish area of Akaroa. For this reason, we do not consider any impacts on the Canterbury aquaculture industry. This information also implies that Styela has not impacted the other regions modelled – Marlborough, Tasman and Nelson, and Southland.

Styela was found to be established in Auckland and the Waikato since 2005, and MAF Biosecurity (2008) suggests that Styela was present in Northland since 2006 at the latest. We use these dates as the arrival time of Styela in each of these regions.

The rate with which Styela spread throughout Auckland, the Waikato and Northland remains unknown. This speed will determine the length of significant impacts for the shellfish industries in each region. Due to the uncertainty in this area, we present these estimates across a range of three spread scenarios. The scenarios consider Styela spreading throughout a region in either 8, 14, or 20 years. The slow rate of spread through the established regions allows us to discount the 2 year spread scenario that was considered in the initial assessment. We maintain the other three scenarios because while Styela was first discovered in New Zealand in 2005, there is uncertainty about how long it was established before detection.



Red shading indicates regions where Styela is present

We model a 10 percent impact on output and production costs based on survey response data.

Based on the above information, we estimate the impact of Styela to be between $0.1 million and $9.4 million. Table 3 presents these results and compares them to the range of impacts that were completed as part of the previous assessment. The estimated actual impact on the sector as a whole

[2] MAF Biosecurity New Zealand, *Sea Squirt (clubbed Tunicate),* available at: [http://www.biosecurity.govt.nz/pests/seasquirt]

tends to be less than the low impact scenario that was assessed in 2005. This is predominately because:

- Styela did not spread to the high value regions of Marlborough and Tasman-Nelson
- The actual share of affected oysters out of the total oyster production is significantly lower than the share included in the 2005 estimate.

Table 3 Estimated actual vs. predicted impacts of Styela 2006-2010

Present value 2006-2010, millions of New Zealand dollars

Full Regional Spread 2011 dollars	8 years $m	14 years $m	20 years $m
Estimated actual impacts			
Auckland/Waikato	9.3	1.1	0.1
Northland	0.1	0.0	0.0
Marlborough	0.0	0.0	0.0
Tasman/Nelson	0.0	0.0	0.0
Southland	0.0	0.0	0.0
Total	**9.4**	**1.1**	**0.1**
Previous assessment (low to high impact scenario range)			
Auckland/Waikato	7.2 - 45.9	1.4 - 9.5	0.1 - 0.6
Northland	0.2 - 1.1	0.0 - 0.1	0.0 - 0.0
Marlborough	3.8 - 25.4	0.3 - 2.2	0.0 - 0.1
Tasman/Nelson	5.0 - 33.6	0.4 - 2.8	0.0 - 0.1
Southland	0.3 - 1.9	0.0 - 0.2	0.0 - 0.0
Total	**16.8 - 110.0**	**2.2 - 14.9**	**0.1 - 0.9**

Source:NZIER

5. Updated impact assessment: 2011-2020

This section presents the updated assessment of the economic impacts of Styela. The time period used in this analysis ranges from 2011 to 2020, with the values discounted back to 2011 at a discount rate of 8 percent[3].

5.1. Regional impacts

As with the 2005 assessment, the results are first presented by region. This is because the rate of spread between the regions is unknown, and the impacts across regions are noticeably different.

Table 4 presents the estimated impacts on the Auckland and Waikato regions from Styela. The estimated impacts range from $18.3 million to $171.2 million, depending on the scenario. The Auckland and Waikato impacts could reduce the value add (or GDP) of the national industry by between 1.4 percent and 12.8 percent, again depending on the scenario.

As expected, the impacts on Auckland and Waikato increase as the effect on output and costs increase. The faster Styela spreads throughout the region, the harsher the impact. The small difference between the 2 and 8 year scenarios is related to the timing of the estimation. The estimate period begins in 2011, implying that Auckland and Waikato have established Styela populations for 6 years. The 2 year spread scenario suggests that Styela is fully established before 2011. In the 8 year scenario, Styela will be fully established in 2013, two years later. This time difference means there are small differences in effect between the two scenarios.

[3] As suggested by Treasury (2008)

Table 4 Impacts on Auckland and Waikato only 2011-2020

Present value of contribution to GDP loss, % of total mussel and oyster value add

Impacts:	Auckland - Waikato from 2005				
Output	5%	5%	20%	20%	35%
Costs	5%	20%	20%	35%	35%
Years to full coverage	**$m**	**$m**	**$m**	**$m**	**$m**
2	28.5	67.4	106.0	138.8	171.2
8	28.3	66.9	105.3	137.9	170.2
14	25.8	61.0	96.3	126.3	156.5
20	18.3	43.4	68.8	90.6	112.7
	% loss	**% loss**	**% loss**	**% loss**	**% loss**
2	2.1%	5.1%	7.9%	10.4%	12.8%
8	2.1%	5.0%	7.9%	10.3%	12.8%
14	1.9%	4.6%	7.2%	9.5%	11.7%
20	1.4%	3.3%	5.2%	6.8%	8.5%

Source:NZIER

Table 5 presents the economic impacts on Northland from Styela. The impacts relative to Auckland and Waikato are small. In the most severe scenario, the impact on Northland could reduce the contribution of the national shellfish industry to GDP by 0.3 percent. This is because a greater proportion of oysters are produced in Northland, and 98 percent of the oyster production is inter-tidal and not affected by Styela.

Table 5 Impacts on Northland 2011-2020

Present value of contribution to GDP loss, % of total mussel and oyster value add

Impacts:	Northland from 2006				
Output	5%	5%	20%	20%	35%
Costs	5%	20%	20%	35%	35%
Years to full coverage	**$m**	**$m**	**$m**	**$m**	**$m**
2	0.6	1.3	2.1	2.7	3.5
8	0.5	1.3	2.1	2.7	3.4
14	0.5	1.1	1.8	2.3	2.9
20	0.3	0.7	1.2	1.5	2.0
	% loss	**% loss**	**% loss**	**% loss**	**% loss**
2	0.0%	0.1%	0.2%	0.2%	0.3%
8	0.0%	0.1%	0.2%	0.2%	0.3%
14	0.0%	0.1%	0.1%	0.2%	0.2%
20	0.0%	0.1%	0.1%	0.1%	0.1%

Source:NZIER

The impacts on Tasman-Nelson are relatively light, ranging from $0.0 million to $10.3 million in the most severe case. This impact is noticeably lower than the estimated impact in the 2005 assessment. The reason for this is that Aquaculture (2010) credits the Tasman and Golden Bays region with approximately 2 percent of national mussel production. The 2005 assessment was based on Tasman/Nelson producing nearly 42 percent of New Zealand's mussels. The difference between the production in 2005 and 2010 appears to have been added to the Marlborough region.

Table 6 Impacts on Tasman-Nelson region

Present value of contribution to GDP loss, % of total mussel and oyster value add

Impacts:	Tasman-Nelson from 2013				
Output	5%	5%	20%	20%	35%
Costs	5%	20%	20%	35%	35%
Years to full coverage	**$m**	**$m**	**$m**	**$m**	**$m**
2	1.7	4.2	6.4	8.5	10.3
8	1.1	2.6	4.0	5.4	6.6
14	0.4	1.0	1.5	2.1	2.5
20	0.0	0.1	0.2	0.2	0.3
	% loss	**% loss**	**% loss**	**% loss**	**% loss**
2	0.1%	0.3%	0.5%	0.6%	0.8%
8	0.1%	0.2%	0.3%	0.4%	0.5%
14	0.0%	0.1%	0.1%	0.2%	0.2%
20	0.0%	0.0%	0.0%	0.0%	0.0%

Source:NZIER

Aquaculture New Zealand (2010) shows that Marlborough is the major mussel producing region in the country. Styela spreading to Marlborough represents the greatest risk to New Zealand. The estimated impacts by region are reported in Table 12. The impacts range from $1.6 million to $383.7 million in the most severe case. It is worth noting that Styela is only fully established in the 2 and 8 year spread scenarios. Under the most severe scenario, the impacts on Marlborough could reduce national mussel and oyster value add by 28.8 percent.

Table 7 Impacts on Marlborough 2011-2020

Present value of contribution to GDP loss, % of total mussel and oyster value add

Impacts:	Marlborough from 2013				
Output	5%	5%	20%	20%	35%
Costs	5%	20%	20%	35%	35%
Years to full coverage	**$m**	**$m**	**$m**	**$m**	**$m**
2	61.2	128.6	232.0	289.9	383.7
8	38.1	80.3	145.8	182.9	243.2
14	14.0	29.6	54.4	68.8	92.3
20	1.6	3.4	6.4	8.2	11.1
	% loss	**% loss**	**% loss**	**% loss**	**% loss**
2	4.6%	9.6%	17.4%	21.7%	28.8%
8	2.9%	6.0%	10.9%	13.7%	18.2%
14	1.0%	2.2%	4.1%	5.2%	6.9%
20	0.1%	0.3%	0.5%	0.6%	0.8%

Source:NZIER

5.2. Benefits from Delayed Spread

Table 8 and Table 9 present the results from some sensitivity analysis. Table 8 shows the impacts on the Marlborough region from Styela arriving five years later, in 2018. The impacts of this scenario range from $0.0 million to $110.6 million, significantly less than the impacts from Styela arriving in 2013. Table 9 reports the specific gains from this delay. Under the most severe scenario, a 5 year delay would reduce the impact on the national sector's value add by 8.3 percent. These results could be used as a cost guide for any government intervention that would delay Styela from spreading to Marlborough for this time.

Table 8 Impacts on Marlborough region after arrival in 2018

Present value of contribution to GDP loss, % of total mussel and oyster value add

Impacts:	Marlborough from 2018				
Output	5%	5%	20%	20%	35%
Costs	5%	20%	20%	35%	35%
Years to full coverage	**$m**	**$m**	**$m**	**$m**	**$m**
2	17.3	36.4	66.1	83.1	110.6
8	3.5	7.5	14.0	17.9	24.3
14	0.2	0.5	0.9	1.1	1.5
20	0.0	0.0	0.0	0.1	0.1
	% loss	**% loss**	**% loss**	**% loss**	**% loss**
2	1.3%	2.7%	5.0%	6.2%	8.3%
8	0.3%	0.6%	1.1%	1.3%	1.8%
14	0.0%	0.0%	0.1%	0.1%	0.1%
20	0.0%	0.0%	0.0%	0.0%	0.0%

Source: NZIER

Table 9 Value of 5 year delay in arrival in Marlborough region

Present value of contribution to GDP loss, % of total mussel and oyster value add

Impacts:	Value of 5 year delay in arrival in Marlborough				
Output	5%	5%	20%	20%	35%
Costs	5%	20%	20%	35%	35%
Years to full coverage	**$m**	**$m**	**$m**	**$m**	**$m**
2	43.9	92.3	165.9	206.8	273.0
8	34.6	72.8	131.8	165.0	219.0
14	13.8	29.1	53.5	67.6	90.8
20	1.6	3.4	6.3	8.1	11.0
	% loss	**% loss**	**% loss**	**% loss**	**% loss**
2	3.3%	6.9%	12.4%	15.5%	20.5%
8	2.6%	5.5%	9.9%	12.4%	16.4%
14	1.0%	2.2%	4.0%	5.1%	6.8%
20	0.1%	0.3%	0.5%	0.6%	0.8%

Source:NZIER

5.3. National Long-term results

The previous results have been presented at the regional level due to the uncertainty around the geographical spread and rate of spread within regions. It is possible to make some conclusions on a national level from these regional results.

As in the previous assessment, the cost and output impacts were modelled to approximate the impacts of Styela outbreaks in Canada. The previous assessment considered the most severe scenarios presented in this modelling as being unlikely long-term impacts. This was because the aquaculture industry would be likely to innovate and adapt to the long-term presence of Styela. While it is likely to negatively impact over the long term, reducing production and increasing costs by 35 percent each was considered to overstate the likely impact over the modelling period.

Based on New Zealand experience of the rate of spread throughout the existing establishments, the previous assessment also discounted the likelihood of a 2 year to full coverage spread.

Due to these considerations, the 2005 assessment provided a smaller range of scenarios to focus on the likely impacts at the national level. We follow the same approach and focus on three scenarios:

- Low impact – 5 percent output loss with 5 percent cost increase
- Medium impact – 5 percent output loss with 20 percent cost increase
- High impact – 20 percent output loss with 20 percent cost increase.

The results for these scenarios are presented in Table 10, under 14 and 20 year to full coverage scenarios. We follow the same geographical spread as in the regional results, but note that the arrival in the regions beyond Auckland, Waikato, and Northland are purely illustrative. The results are presented as the present value of the impacts between 2011 and 2020. These results show national Styela impacts ranging from $20.4 million to $157.3 million, depending on the scenario.

Table 10 Regional economic impacts of Styela Clava

Present value of impacts 2011-2020, millions of New Zealand dollars

		20 year full regional spread			14 year full regional spread		
Impact Scenario		**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
Output		5%	5%	20%	5%	5%	20%
Costs		5%	20%	20%	5%	20%	20%
PV Loss		**$m**	**$m**	**$m**	**$m**	**$m**	**$m**
Auckland/Waikato	2005	18.3	43.4	68.8	25.8	61.0	96.3
Northland	2006	0.3	0.7	1.2	0.5	1.1	1.8
Tasman/Nelson	2013	0.0	0.1	0.2	0.4	1.0	1.5
Marlborough	2013	1.6	3.4	6.4	14.0	29.6	54.4
Southland	2013	0.1	0.3	0.4	0.9	2.2	3.4
Total sector impacts		**20.4**	**47.9**	**76.9**	**41.5**	**94.8**	**157.3**

Source:NZIER (2005)

Table 10 also shows the potential benefits of stopping or delaying the spread of Styela to new regions, and of slowing the spread of Styela within a region. If Styela was restricted to existing establishments then the national impact would decrease to a range of $18.6 million to $98.1 million. Similarly, if the intra-regional spread of Styela was to be slowed from 14 years to 20 years, then the range of potential impacts would fall from $41.5 million to $157.3 million to $20.4 million to $76.9 million. The change in impacts from these delays could be used as a guide for assessing any government intervention programmes.

Appendix 1 – Detailed Methodology

Baseline scenario

This update models the impacts of Styela on the main shellfish producing regions of New Zealand, as it is the aquaculture sector that is most likely to be impacted by Styela. To assess the impacts of Styela, we compare the impacted scenarios against a baseline scenario. In this case the baseline scenario is a forecast of revenue in the mussel and oyster sectors between 2008 and 2025, provided by Aquaculture New Zealand. Details of these forecasts are provided in Table 11.

Table 11 Aquaculture forecasts

New Zealand dollars, millions

	2008	2011	2015	2020	2025
Mussels					
Domestic	35	43	59	77	57
Export	204	226	302	387	427
Total	**239**	**269**	**361**	**464**	**484**
Oysters					
Domestic	9	10	12	13	14
Export	17	21	26	30	34
Total	**26**	**31**	**38**	**43**	**48**

Source:Aquaculture New Zealand

Our model requires these national forecasts to be split to a regional level. Our starting point is the regional production map included in New Zealand Aquaculture Farm Facts (Aquaculture New Zealand, 2010). We then follow the same methodology as the 2005 assessment, which modifies the regional production share based on the relative importance of different regions. Table 12 shows the share of national production for each shellfish producing region at the beginning and end of the time period.

We are also interested in the impact of Styela on production costs. The 2005 assessment was informed by a 1999 economic study of the mussel industry, which showed that the industry's value

add was approximately 55 percent of its revenues (Philip Donnelly & Associates, 1999)[4]. This suggests that the remaining 45 percent was related to intermediate consumption. The previous assessment used the intermediate consumption parameters for different regions as a basis for the Styela related impacts on production costs.

While there are some more recent studies of individual regions' industries, there have not been any more recent investigations of the national industry. Estimates based on consistent methodologies are preferred. For this reason we have followed the previous assessment and applied the national estimates from Philip Donnell & Associates (1999) to this update.

Table 12 Regional production without Styela clava

Percentage of national production

	Mussels		Oysters	
	2011	**2020**	**2011**	**2020**
Northland	0.3%	0.4%	46.1%	46.9%
Auckland	3.0%	3.0%	30.0%	30.2%
Waikato/Coromandel	19.1%	20.0%	19.0%	19.0%
Nelson/Tasman	2.0%	1.9%	0.0%	0.0%
Marlborough	70.6%	69.1%	4.8%	3.8%
Canterbury	1.0%	1.1%	0.1%	0.1%
Southland	4.0%	4.4%	0.0%	0.0%

Source:NZIER

Range in impacts

The impacts of Styela will depend on:

- When it arrives in each region
- How quickly it spreads throughout a region
- How it affects the production and costs of the shellfish industry.

There is considerable uncertainty around these factors. To reflect this uncertainty we present a range of scenarios related to the spread and impact of Styela.

[4] This figure is broadly similar to the level of value add that was indicated in the forecasts provided by Aquaculture New Zealand

As in the previous assessment, we consider low, medium, and high impacts on both production and cost impacts. We also present scenarios where Styela can spread throughout a region in 2, 8, 14, or 20 years, where the impacts increase by 50 percent each year until Styela is fully spread throughout the region.

Distribution

As discussed above, Styela was first detected in Auckland, the Coromandel, and Lyttelton Harbour in 2005. Since then it has also become established in Northland. The previous assessment reviewed the habitat requirements of Styela and concluded that it could probably survive in waters anywhere around New Zealand. This suggests that Styela could become successfully established in all of New Zealand's shellfish producing regions.

As noted in the previous assessment, Styela has a short free-floating larval stage, which suggests that any inter-regional spread related to currents and tidal movements is likely to be low. This implies that the continuing spread of Styela is likely to be caused by human related activities. Examples of how Styela could be distributed from the existing establishments to areas of high value aquaculture are discussed in MAF Biosecurity New Zealand (2008). It suggests four human related vectors that could distribute Styela. They are:

- Recreational boating
- Commercial shipping
- Aquaculture activities
- Towed barges/structures.

We follow the same methodology as the previous economic impact assessment, and model the distribution of Styela as being established in Auckland and Waikato in 2005, Northland in 2006, and then the remaining regions within two years from now, 2013. We note that the likely spread of Styela beyond the existing establishments is unknown and the current scenario is illustrative only. As discussed above, we provide scenarios of the different speed of spread in a region.

Sector impacts

As discussed for the sector impacts of didymo, the full range of effects of Styela should be considered in any economic impact assessment, and they will include the same range discussed here. Unfortunately, suitable data is not available to quantify all of these effects. The impacts that this assessment does cover are:

- Reduction in production of mussels and oysters
- Increase in costs associated with mussel and oyster production.

This reflects the view that the main impacts of Styela are likely to be felt in the mussel and oyster sectors. The previous assessment noted that this is likely to be because of these sectors' use of built structures in the sea, to which Styela can attach itself; and because Styela could compete with existing aquaculture species for space and food on those structures.

It should be noted that Styela is only expected to impact on the oysters that are from farms that use sub-tidal production methods, which represent approximately 2 percent of New Zealand's current oyster production (Aquaculture New Zealand, 2011). This is because the remaining 98 percent of oyster production is produced in inter-tidal zones, which exposes the oysters to air for 2 of every 6 hour tide cycle. Styela are unlikely to settle in these conditions.

MAF Biosecurity New Zealand has listed the aquaculture industry and New Zealand's biodiversity as being potentially threatened by Styela. Impacts of Styela may be felt in areas other than the aquaculture industry, such as New Zealand's biodiversity. These other areas are not included in the model due to data limitations. Other excluded potential impacts are:

- Recreational and tourism activities (such as diving)
- Other small aquaculture and fishing activities
- Social and cultural impacts, such as the change in the biodiversity of the aquatic environment.

The types of information used in this assessment include official statistics from Statistics New Zealand, sector specific data provided by industry bodies, previous estimates from the literature, and survey response data.

Mussels and oysters

The previous assessment considered Styela to have two main impacts on the mussel and oyster sectors. First, production may fall due to Styela competing for space and food with mussels and oysters. Secondly, production costs may increase as extra work is required to preserve the productivity of the farms. We follow the previous assessment and model these two impacts.

Estimates of the scale of the impact of Styela on the mussel industry are scarce. The low, medium, and high impact scenarios from the previous assessment were informed by a 2005 study that investigated the impacts on Styela on the mussel industry in Prince Edward Island, Canada[5]. We are not aware of more recent studies, so follow the methodology of the previous assessment.

The same set of production and cost impact scenarios are applied as in the 2005 assessment, which were:

- Low impact scenario of 5 percent

[5] Davidson, J., Arsenault, G., MacNair, N., Landry, T., & Bourque, D. (2005), Reproduction, epidemiology and control of the clubbed tunicate, Styela clava, Prince Edward Island Aquaculture & Fisheries Research Initiative Project #043AR15, PEI Aquaculture Alliance.

- Medium impact scenario of 20 percent
- High impact scenario of 35 percent.

The previous assessment varied the combinations of impacts between the production loss and cost increase scenarios, as shown in Table 13. This variation allowed for a range of impacts on industry value-add that were similar to the Canadian study.

Table 13 Production and cost scenarios

Impact assumptions						
Production loss		5%	5%	20%	20%	35%
Cost increase		5%	20%	20%	35%	35%
	Base					
Output	100	95.0	95.0	80.0	80.0	65.0
Intermediate consumption	45	44.9	51.3	43.2	48.6	39.5
Value added	**55**	**50.1**	**43.7**	**36.8**	**31.4**	**25.5**
Change from base		*-9%*	*-21%*	*-33%*	*-43%*	*-54%*

Source:NZIER

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