



Assessment of the
Victorian Developmental Jellyfish Fishery

Environment Australia

March 2003

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ISBN: 0642549176

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This document is an assessment carried out by Environment Australia of a commercial fishery against the Commonwealth's Guidelines for the Ecologically Sustainable Management of Fisheries. It forms part of the advice provided to the Minister for the Environment and Heritage on the fishery in relation to a decision under Part 13A of the EPBC. The views expressed do not necessarily reflect those of the Minister for the Environment and Heritage or the Commonwealth Government.

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**Assessment of the ecological sustainability of management arrangements for the
Victorian Developmental Jellyfish Fishery**

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EXECUTIVE SUMMARY

Background

The Department of Natural Resources and Environment (NRE) has submitted a document for assessment under Part 13A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The document *Developmental Fisheries Management Plan Jellyfish* (the submission) was received by Environment Australia (EA) in September 2002. A period of discussion between NRE and EA followed, during which preliminary drafts were refined. The submission was released for a twenty business day public comment period that expired on 9 December 2002. Two public comments were received and NRE provided a response to the issues raised. No changes were made to the submission as a result of public comment.

The submission reports on the management arrangements for the Victorian Jellyfish Fishery. The EA assessment considers the submission and associated documents, public comments and NREs response to the comments, against the Commonwealth *Guidelines for the Ecologically Sustainable Management of Fisheries*.

Summary of the Victorian Jellyfish Fishery

Area	Port Phillip Bay, Western Port Bay, Corner Inlet and Gippsland Lakes
Fishery status	The target species is under fished
Target Species	<i>Catostylus mosaicus</i>
Byproduct Species	No byproduct species permitted
Gear	Hand dip-netting from vessels only. Seine nets (<250m long and >10cm mesh size) for herding and coralling purposes only
Season	Limited to months February to June inclusive
Commercial harvest proposed for 2003	1500t wet whole weight
Estimated value of commercial harvest 2003	\$2.7 to \$3.4 million (based on a recovery rate of 14%) <u>Note:</u> to date fishery has only caught 200kg per season and has therefore not fully explored the market
Recreational and indigenous harvest	No significant recreational or indigenous take of target species
Fleet	It is anticipated that up to 5 boats will be used
Permit holders	One developmental permit has been issued
Management arrangements	Input controls: boat and gear restrictions, and spatial and temporal closures Output controls: total allowable developmental catch limit, size limit
Export	Jellyfish products for export to Asia
Bycatch	Uncertain, possibly other jellyfish and fish species
Interaction with Threatened Species	Uncertain, thought to be minimal

The Victorian Jellyfish Fishery (VJF) is a developmental fishery for the life of the current plan (2003-2005). After this time it may be expanded to a commercial fishery if evidence suggests that it is viable.

The VJF operates in the waters of Port Phillip Bay, Western Port Bay, Corner Inlet and Gippsland Lakes only. The principle fishing area does not extend into Commonwealth waters. Following further stock investigations NRE may approve the opening of other geographical boundaries.

The VJF targets *Catostylus mosaicus* jellyfish. There is a total allowable developmental catch (TADC) set for 2003 of 1500t (wet whole weight), with a minimum wet bell diameter of 23cm. No other species are allowed to be taken as byproduct.

C. mosaicus is very common in temperate and tropical waters of Australia, especially along the eastern coastline of Australia, with the species occupying waters from the Torres Strait and Northern Territory to Port Phillip Bay in Victoria. The genus *Catostylus* also occurs in New Zealand and other Indo-Pacific regions, particularly the Philippines. Two or three species occur on the Atlantic coasts of Africa and Europe. This species is known to congregate in large aggregations in coastal waters and estuaries with stock units restricted to individual bays and estuaries.¹

The jellyfish's medusa stage, which is subject to harvesting, is believed to have a very limited lifespan (about five months) after which the animals die. There appears to be a high level of annual variation in abundance for the species. It is thought that the variation may be a result of water temperature and salinity changes, however this is not yet confirmed.

C. mosaicus is prey to turtles (particularly leatherback turtles), some bony fish, crabs, sunfish and some birds of prey.² Pitt (1998) states that jellyfish form an important part of the diet of a variety of fish species and its importance is likely to be underestimated due to the difficulty of identifying jellyfish in the gut of animals.

Biomass estimates of *C. mosaicus* have been conducted in Port Phillip Bay in 2001 and 2002. The results of these stock assessments suggest that the average commercial biomass (greater than 23cm in bell diameter) in Port Phillip Bay is 10 000 wet tonnes. A TADC of 1200t has been set as a result of these estimates. Each of the other three geographical areas have been assigned 100t wet weight each as a preliminary developmental take.

The catch value of the maximum TADC depends on the grading of catch into high and low value product. The current wholesale price ranges from \$13 000 to \$16 000 per processed tonne. If a recovery rate of 14% is achieved, then 210 processed tonnes (bells) could be produced from the TADC valued in the order of \$2.7 million to \$3.4 million. Dried jellyfish is sold to Asian markets, primarily China and Japan.

The VJF will harvest *C. mosaicus* through the use of hand dip-netting from vessels. The use of seine nets (no greater than 250m in length and mesh size no smaller than 10cm) may be used for herding and corralling purposes only. All fishing gear must comply with the provisions of the appropriate net regulations under the Victorian *Fisheries Act 1995*, and may only be used in accordance with existing management policies, plans, rules or regulations governing other species, area or gear specific fisheries. Harvesters will be limited to existing licensed commercial fishers and will fish from existing licensed vessels. The fishery will be limited to the months February to June of each year, inclusive, with a possible extension past June if growth rates indicate further development in July.

¹ Queensland Fisheries Service 2001

² IBID

Dip netting will only have a minimal impact on the environment as jellyfish tend to swim at the surface leaving little space for anything else. Some evidence does exist that jellyfish act as fish attraction devices to juvenile finfish, so there may be some interaction with these species whilst dip netting occurs. It is unclear what impact the removal of *C. mosaicus* would have on the ecosystem within the VJF. These interactions are assessed under Principle Two of this report.

There is no significant take of *C. mosaicus* by the indigenous and recreational sectors, however some may be taken as bycatch in other fisheries. This is discussed further in Principle Two of this report.

The fishery is managed under the *Developmental Fisheries Management Plan: Jellyfish (Catostylus mosaicus) 2003 – 2005*, which obtains its authority under the *Victorian Fisheries Act 1995*. The Victorian Department of Natural Resources and Environment maintains the authority to manage the fishery.

Overall assessment

The material submitted by NRE for assessment of the VJF shows the fishery is consistent with the objects of Part 13A. However, Environment Australia has several concerns regarding this fishery. Key areas requiring further development include:

- Increased data gathering and reporting as part of the annual review of the ecological sustainability of the fishery, and incorporation of this data into management arrangements;
- Clarification and further development of performance indicators, reference points and management responses;
- A comprehensive stock assessment which can then be used to define a more meaningful TADC for the fishery; and
- Further research into the biology and ecology of *C. mosaicus* and the ecological impact of the fishery.

Under the specified management arrangements, EA is satisfied that the fishery will not be detrimental to the survival or conservation status of the jellyfish *C. mosaicus*. Similarly, it is not likely to threaten any relevant ecosystem. EA therefore recommends that the fishery is declared an approved Wildlife Trade Operation (WTO) with the actions specified in the recommendations below as conditions to the declaration. This declaration would be effective for a period of three years. The WTO declaration will require annual reporting on the progress of implementing the conditions and other managerial commitments.

The fishery is currently very small, with only one permit and a history of around 200kg of annual take. The risk of this fishery being unsustainable for the target species or impacting significantly on the ecosystem is minimal. However EA is seeking a precautionary approach due to the potential of the VJF to expand. EA has made a number of recommendations that will not only improve management of the fishery in its current developmental phase, but will also introduce management practices that will ensure ecologically sustainable management throughout the fishery's development and expansion.

These recommendations are:

1. The review of the ecological sustainability of the fishery to be provided to EA annually.
2. From 2003 the review of the ecological sustainability of the VJF is to include:
 - Analysis of any reported interactions, or observances of, protected species in the fishery; and
 - Information collected by the monitoring and reporting of any bycatch activity by permit holders in the fishery.
3. Clearer performance indicators, associated reference points and management responses to be developed and implemented in the fishery within two years.
4. The management plan to incorporate an aim to minimise the impact on the structure, productivity, function and biological diversity of the ecosystem within the life of the current management plan.
5. EA to be informed of any changes to the developmental fishery management plan.
6. A mechanism is to be developed to enable the amendment of management arrangements to respond to new information, or future Government plans and policies within the life of the current management plan.
7. Stock biomass estimates of Western Port Bay, Corner Inlet and Gippsland Lakes to be completed by the end of 2004 and be fed into the adaptive management plan.
8. Further research into the biology of *Catostylus mosaicus* to be conducted by 2005. In particular, focus to be given to causes of annual variation, ecosystem role of *C. mosaicus* and reproductive biology of *C. mosaicus*.
9. Mortality of the VJF *C. mosaicus* stocks due to bycatch in other fisheries is to be estimated and incorporated in the setting of catch limits under the adaptive management plan.
10. NRE to develop the adaptive management plan and forward it to the Minister for approval by the end of 2003. The plan should then be implemented for the 2004 season.
11. The priority research projects identified in the management plan to be completed in the next three years. These include: the monitoring of bycatch and reporting of other species in areas of conglomeration; investigating the diet of jellyfish and drawing inferences as to the effects of jellyfish removal on populations of prey species; and reproduction and polyp stage dynamics. EA to be regularly updated on the progress of the research projects.
12. An investigation of the ecological impact of the fishery to be carried out in 2004.

PART I - MANAGEMENT ARRANGEMENTS

The Victorian Jellyfish Fishery (VJF) is managed by the Victorian Department of Natural Resources and Environment (NRE). The management regime is described in the following documents, all of which are, or will be, publicly available:

- The *Developmental Fisheries Management Plan: Jellyfish (Catostylus mosaicus) 2003 – 2005*
- The Victorian *Fisheries Act 1995*
- Relevant Gazettal notices and licence conditions

There are a number of other documents, including research reports, scientific literature and discussion papers, that are relevant to management of the fishery.

The management plan specifies performance indicators that include catch and effort, and size constancy. These performance indicators are very broad and do not have associated reference points. EA recommends that the performance indicators be refined and appropriate reference points be developed. To ensure that appropriate action is taken when the performance indicators are reached, management responses should also be developed. This will achieve a more strategic management approach, including criteria by which the management arrangements can be measured.

The VJF management plan outlines a number of aims of the plan. These aims are:

- to ensure the conservation of *Catostylus mosaicus* in Victorian waters;
- to provide the basis for legislation to restrict access to this fishery by species, fishing method and geographical area; and
- to establish a suitable regulatory regime and ensure orderly development of the fishery, which will include continual monitoring and assessment.

The *Guidelines for the ecologically sustainable management of fisheries* states that the management arrangements must be strategic, containing objectives that will assist it with achieving ecologically sustainable management. The VJF does not currently incorporate an ecological objective. EA therefore recommends that NRE develop a strategic objective that will aim to minimise the impact of the fishery on the structure, productivity, biological function and biological diversity of the ecosystem.

A review will be conducted each year as to the ecological sustainability of the developmental fishery. The review will include analysis of stock abundance, stock quality, processing quality and socio-economic implications. EA believes that the review should include analysis of the ecological impact of the fishery and provided to EA annually. This will be further discussed in Part 2 of this report.

The review of the ecological sustainability of the fishery is an important part of the management arrangements and has played a significant role in this assessment. It is important that the completion of these annual reviews is transferred into the actual management actions. The management plan states that these reviews will be implemented in the fishery to ensure the conservation of *C. mosaicus* in Victorian waters and to establish a suitable regulatory regime and ensure orderly development of the fishery. EA commends this commitment to implement the outcomes of the review in the management arrangements.

The peak bodies (Fisheries Co Management Council and Seafood Industry Victoria) have been consulted on the development of the management plan. EA considers that this consultation should be ongoing through the life of the developmental fishery. While EA

considers that this is sufficient for the fishery at this stage in its development, EA advises management to consider expanding consultation to scientific representatives, Non-Government Organisations and other relevant stakeholders in the future, particularly if there is any proposal to extend the fishery beyond a developmental take.

Management of the fishery is based on both input and output controls. Such controls include:

- Gear and vessel restrictions;
- Limited fishing area (Port Phillip Bay, Western Port Bay, Corner Inlet and Gippsland Lakes only);
- Restricted fishing season (February to June);
- Annual Total Allowable Developmental Catch (TADC); and
- Target species size limit (minimum 23cm bell diameter).

Fishing methods are restricted to hand dip-netting from vessels, with the use of a seine net for the purposes of herding and corralling purposes only. Fishers will be limited to existing licensed commercial fishers and can only fish from existing licensed vessels. Potentially the operation could generate sufficient return to attract fishers to mix this fishery with their current operations. Each of the 4 bays and inlets will be treated as discrete fisheries at this stage.

The compliance authority for the VJF is Fisheries Victoria Compliance Branch. The penalty for failing to observe a condition of the permit is non-renewal of that permit in addition to any other penalty prescribed or otherwise provided for by condition of the permit or current legislation. Any breaches of fisheries legislation may also cause the cancellation or suspension of a permit issued under the management plan. Due to there being one operator and their involvement in managerial decisions, it is likely that the operator will feel an ownership of the management arrangements and is therefore far more likely to comply with them. EA considers that the compliance strategy for the VJF contains the means of enforcing critical aspects of the management arrangements.

Fishery dependant and independent information relating to the target species will be collected on a regular basis in the fishery. Fishery dependent data is obtained through the compulsory logbook. A detailed logbook is required to be submitted fortnightly to the Marine and Freshwater Resources Institute (MAFRI) and include details on catch weight, geographic time and positions, and observance of other species. Validation of logbooks will be undertaken by MAFRI staff which will include the occasional use of trip inspectors. EA is satisfied that these compliance measures contain the means of enforcing the critical aspects of the management arrangements.

MAFRI will also be monitoring the biomass in Port Phillip Bay and will conduct a yearly survey to determine an estimate of stock abundance over the three year period. Further biomass estimates will be carried out in Western Port Bay, Corner Inlet and Gippsland Lakes. These information collection systems are discussed further under Part Two of this report.

An analysis of the fishery's capacity to assess, monitor and avoid, remedy or mitigate any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates is covered under Principle Two of this report.

EA is satisfied that the current management arrangements comply with all relevant threat abatement plans, recovery plans, the National Policy on Fisheries Bycatch, and bycatch action

strategies developed under that policy. However, there is no mechanism in the arrangements that requires compliance with any future plans or policies. With the potential growth and development of this fishery it is important that such mechanisms be introduced at an early stage and EA recommends that this be incorporated in the management plan.

The submission suggests that the fishery has great potential for further expansion of catch and production. The demand for jellyfish product on the Asian market is growing by 25% per annum, and a number of overseas investors are interested in the fishery. It is therefore important at this early stage that management arrangements are put in place that will ensure the fishery remains ecologically sustainable throughout its development and provide a basis of sound management if, in the future, the fishery expands.

NRE has advised EA that if the fishery becomes commercially viable then a quota managed fishery will be established. EA is not able to provide advice on this form of management at this stage and would have to reassess the management of the fishery, if this were to happen.

The submission states that the harvesting of jellyfish will not raise any significant pollution issues. Where these are identified, management have agreed to modify permit conditions.

Conclusion

Management arrangements in the VJF are reasonably precautionary. NRE has demonstrated its commitment to the ecologically sustainable management of the fishery by establishing a suitable precautionary regime to ensure ecologically sustainable development if the fishery is to expand. The management plan provides for adaptive management arrangements based on specified research and EA is confident that through this research, NRE will manage the fishery in a precautionary way.

Regular reviews and reporting on the fishery would ensure that the management remains publicly available and transparent. EA recommends that NRE ensure their annual review on the ecological sustainability of the fishery is publicly available and provided to EA on an annual basis.

The current management plan specifies performance indicators, however they are very broad and contain no reference points or management responses. Although EA is satisfied that this will not cause issues in the fishery in the short term, we recommend that clearer performance indicators are identified and associated reference points are determined. A clear process for the implementation of management responses to a breach of reference points should also be developed. EA further recommends that the management plan incorporate an aim to minimise the impact on the structure, productivity, function and biological diversity of the ecosystem.

EA considers it important that, because of the developmental nature of the fishery, management arrangements remain flexible to ensure timely and appropriate managerial decisions. Thus EA supports an adaptive management plan but ask to be kept informed of any changes, in order to assess whether it changes the assessment. EA therefore recommends that NRE inform EA of any changes to the management plan.

The current management arrangements for the VJF fishery do not require the amendment of management practices to comply with all relevant threat abatement plans, recovery plans, the National Policy on Fisheries Bycatch, and bycatch action strategies in the future. EA

recommends that a mechanism be developed to enable the amendment of management arrangements to respond to new information, or future Government plans and policies.

Recommendations

- The review of the ecological sustainability of the fishery to be provided to EA annually.
- Clearer performance indicators, associated reference points and management responses to be developed and implemented in the fishery within two years.
- The management plan to incorporate an aim to minimise the impact on the structure, productivity, function and biological diversity of the ecosystem
- EA to be informed of any changes to the management plan.
- A mechanism is to be developed to enable the amendment of management arrangements to respond to new information, or future Government plans and policies within the life of the current management plan.

PART II – GUIDELINES FOR THE ECOLOGICALLY SUSTAINABLE MANAGEMENT OF FISHERIES

Stock Status and Recovery

Principle 1: *‘A fishery must be conducted in a manner that does not lead to over-fishing, or for those stocks that are over-fished, the fishery must be conducted such that there is a high degree of probability the stock(s) will recover’*

Maintain ecologically viable stocks

Objective 1: *‘The fishery shall be conducted at catch levels that maintain ecologically viable stock levels at an agreed point or range, with acceptable levels of probability’*

Information requirements

Fishery dependent data is obtained from compulsory fortnightly logbooks submitted to MAFRI. The logbook contains information on total wet weight (including tentacles) caught, geographic position and time, and observance of other species or other occurrences that reveal interactions with the environment. Validation of logbooks will be undertaken by MAFRI staff which will include the occasional use of trip inspectors. Although occasional trip inspections is adequate for current fishing levels, as the fishery develops NRE will need to provide as appropriate level of observer coverage. Observer coverage is not only a compliance method, but will also assist with information collection for bycatch and ecosystem interactions, as discussed later in the report.

The abundance and biomass of *C. mosaicus* in Port Phillip Bay has been assessed using a stratified random sampling design with size frequency samples taken by dip net. These fishery independent surveys will continue to be conducted twice yearly to monitor the biomass in Port Phillip Bay and determine an estimate of stock abundance over the next 3 years in order to ascertain annual fluctuations. Further biomass estimates will be carried out in Western Port Bay, Corner Inlet and Gippsland Lakes to ascertain order of magnitude estimates of biomass in the 2004 and 2005 seasons. At the time of assessing the VJF these estimates were not available. EA recommends that estimates of stock biomass in Western Port Bay, Corner Inlet and Gippsland Lakes be completed by the end of 2004. These estimates should be used to re-assess the current TADCs for these areas, to ensure that the catch limits are set at a precautionary level.

Assessment

The submission states that there is no significant recreational or indigenous take of the target species. The nature of the fishery, including the knowledge and investment in the processing sector, makes it unlikely that other commercial fisheries would be keeping jellyfish as byproduct. Most fisheries attempt to avoid catches of jellyfish as it clogs nets and can mean loss of target species, however a significant number of jellyfish continue to be taken as bycatch. EA considers that the data collection system ensures that reliable estimates of commercial removals are available.

Kingsford and Gillanders (1995) state that jellyfish are likely to have a high resilience to exploitation due to a short life span and high fecundity of the medusae, coupled with the

capability of polyps to asexually reproduce. As the medusae have a short life span, recruitment is the sole source of the stock each year. This reinforces the importance of further research into factors affecting recruitment to further inform and assist in appropriate management of the stock. NRE have committed to conducting research into the diet of jellyfish, and reproduction and polyp stage dynamics by 2005.

The stock biomass of jellyfish in Port Phillip Bay is extremely variable, and concern over this was raised during the public comment period. The submission suggests the variability could be a result of changes in water temperature and/or salinity, however this is unconfirmed. There are a number of information gaps regarding biology of *C. mosaicus*, particularly recruitment, variations in abundance and the species position in the ecosystem. It is important that the species is further understood before a full commercial fishery is pursued, and EA therefore recommends that further research into the biology of the species be undertaken by NRE and MAFRI. In particular EA highlights the importance of further research into:

- causes of annual variation (eg. the effect of water temperature and salinity on recruitment)
- ecosystem role of *C. mosaicus* (eg. Jellyfish diet, prey species, jellyfish as an aggregating device)
- reproductive biology of *C. mosaicus* (eg. annual spawning period and recruitment dynamics)

The distribution of the target species is well understood. *C. mosaicus* stock units are considered to be restricted to individual bays and estuaries. Management of the VJF takes this into account through the setting of individual TADCs for each bay and inlet.

Management response

The current management plan aims to establish a suitable regulatory regime and ensure orderly development of the fishery, which will include continual monitoring and assessment. As the fishery develops this will be achieved through the use of management controls involving a quota mechanism supported by licensing, and gear and area controls. The impacts of environmental conditions, such as salinity and water temperature, will also be investigated by NRE to determine impacts on recruitment. The monitoring of bycatch and benthic disturbance will be carried out during the period of the plan to determine the suitability of the fishing technology engaged in harvesting. This will be further discussed later in the report.

Harvesting is limited to Port Phillip Bay, Western Port Bay, Corner Inlet and Gippsland Lakes and is restricted to the months of February to June inclusive. An extension past June may be permitted if growth rates indicate further development. The timing associated with the attainment of maximum growth will be carefully monitored. EA is satisfied that the surveys and annual review will be sufficient to detect trends in catches.

Kingsford and Pitt (1998) found that spawning of *C. mosaicus* in New South Wales commenced with the approach of spring and therefore closing the season during this time would provide an opportunity for the medusae to spawn. However it was also noted that timing of reproduction and recruitment would vary with latitude, and therefore collecting this information for the target areas is of high importance. EA is satisfied that the current season is a precautionary approach that should allow the species to spawn, however further research into the biology of *C. mosaicus* to include spawning periods within this fishery is recommended.

Ideally, management arrangements affecting a single stock should be under a single jurisdiction, or at least complementary across jurisdictions. EA is satisfied that the target species retained in this fishery is independent within Victorian waters.

The management plan states that jellyfish bycatch is significant in a number of fisheries within the bounds of the VJF and EA is concerned that this significant mortality is not incorporated in the setting of catch limits for the stock. Currently the methods of fishing do not allow for a high level of survivorship of the species. Although it is possible that as this fishery progresses there may be a change in the way this bycatch is handled, any significant mortality of the target stock should be taken into account in stock assessments. EA recommends that mortality of VJF *C. mosaicus* stocks caused by bycatch in other fisheries be considered in setting the catch limit.

The submission states that the TADC is a conservative amount that has been set on the basis of previous stock assessments. Stock assessments have shown *C. mosaicus* to be more abundant in Port Phillip Bay, therefore the bulk of the TADC (1200t) will be harvested there. A 100t TADC has been allocated to the other three permitted areas. The submission advises that these allocations for Western Port Bay, Gippsland Lakes and Corner Inlet are conservative estimates. The collection of logbook data during the fishing of these areas will also be beneficial in further clarifying stock biomass estimates in the bays and inlets. These areas will only be fished if the TADC for Port Phillip Bay is reached, in which case fishing will be moved to the other bays and inlets.

In 2001 the commercial biomass ranged from 7,500 wet tonnes to 17,000 wet tonnes. In 2002 the commercial biomass was found to have decreased by 80% to 3000t, however the TADC remained the same. While it is understood that the fishers are likely to respond to such a drop in biomass and fishing may no longer be economical the ability to catch the full TADC remains. Potentially the TADC could be a large proportion of the stock in a year of low biomass.

NRE has advised EA that after the first year of the declaration the TADC will be changed to a precautionary upper limit, based on an adaptive management plan that takes into account catch per unit effort (CPUE) and biomass estimates. Little information on the adaptive management plan has been provided to EA.

As this adaptive management plan will be utilized within the life of the proposed declaration, EA must approve the method. EA therefore recommends that NRE develop the adaptive management plan and implement it within one year subject to the approval of the plan by the Minister. This adaptive management plan should be formulated to achieve a TADC that is responsive to variations in abundance of the stock, leaving a predetermined proportion of the stock for ecosystem function and provide a suitably precautionary catch limit for the fishery.

EA noted that NRE uses CPUE as a management tool within the VJF. Catch and effort is not a good performance indicator for species that aggregate, since once an aggregation is located large numbers can be harvested with little effort, even when the average abundance is low. The CPUE can therefore remain high despite low levels of the species being available.³ EA therefore advises caution in using CPUE as a management tool in this fishery.

³ Pitt 1998

The uncertainty associated with recruitment of the species, its role in ecosystem function and annual variation gives reason to be particularly precautionary at this stage of development in the fishery. Once more information on the species is obtained a more comprehensive stock assessment can be conducted, including consideration of mortality in other fisheries and annual variation. This information can then be used to develop a more meaningful catch limit for the species.

As much as 45% of the total weight of *C. mosaicus* is tentacles. The current plan states that tentacles are to be ground and disposed of in deep water, however investigations will be undertaken to see whether the tentacles could be used for some byproduct.

Conclusion

In order to maintain informed management arrangements it is important that NRE obtain stock biomass estimates for all bays and inlets of the fishery. EA recommends that stock biomass estimates for Western Port Bay, Corner Inlet and Gippsland Lakes be obtained by the end of 2004. The current TADCs for these areas should be re-assessed in light of these estimates to ensure that an ecologically sustainable level of take is maintained.

At present there is a lack of information on the biology of *C. mosaicus*, and this was raised as a concern in public comment. In order to facilitate the development of appropriate management of the species, EA recommends that further research into the biology of the species be undertaken by NRE and MAFRI, particularly in reference to causes of annual variation, the ecosystem role of the species and reproductive biology of *C. mosaicus*. This development in the understanding of the species biology and ecological position will allow a more comprehensive stock assessment and greater confidence in development of catch limits.

Concern over the setting of a meaningful TADC was raised in public comment. The catch limit should be responsive to annual variations in abundance and mortality in other sectors of the fishing industry. In order to obtain a more meaningful catch limit on which to base management of the fishery, EA recommends that the mortality of the VJF *C. mosaicus* stocks due to bycatch in other fisheries, be incorporated in the setting of catch limits. EA is concerned that the extreme variability of the stock is not accounted for in the management arrangements of the fishery. The current TADC could potentially lead to the overfishing of the stock in years of low abundance.

NRE has committed to the development of an adaptive management plan for setting the TADC after the first year of the plan (2003). In approving the fishery for a WTO, EA must be confident that the fishery is conducted in a manner that maintains ecologically viable stock levels. Without details of the adaptive management EA is unable to approve the approach. EA therefore recommends that NRE develop the adaptive management plan and forward it to EA for approval within the first year of the plan. The adaptive management plan should then be implemented in time to set the TADC for the 2004 season.

Recommendations

- Stock biomass estimates of Western Port Bay, Corner Inlet and Gippsland Lakes to be completed by the end of 2004 and be fed into the adaptive management plan.
- Further research into the biology of *Catostylus mosaicus* to be conducted by 2005. In particular, focus to be given to causes of annual variation, ecosystem role of *C. mosaicus* and reproductive biology of *C. mosaicus*.
- Mortality of the VJF *C. mosaicus* stocks due to bycatch in other fisheries is to be estimated and incorporated in the setting of catch limits under the adaptive management plan.
- NRE should develop the adaptive management plan and forward it to the Minister for approval by the end of 2003. The plan should then be implemented for the 2004 season.

Promote recovery to ecologically viable stock levels

Objective 2: *‘Where the fished stock(s) are below a defined reference point, the fishery will be managed to promote recovery to ecologically viable stock levels within nominated timeframes’*

This objective is not applicable to the fishery at present.

Ecosystem impacts

Principle 2: *‘Fishing operations should be managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem’*

Bycatch protection

Objective 1: *‘The fishery is conducted in a manner that does not threaten bycatch species’*

Information requirements

Permit holders are required to record in logbooks ‘observance of other species or other occurrences that reveal interactions with the environment.’ This information is intended to be used by MAFRI to monitor the occurrence of any bycatch in the fishery.

While the fishery harvests *C. mosaicus* using hand dip-nets only, seine nets may be used for herding and corralling purposes. The submission states that no bycatch will be caught or damaged during the process of corralling, however Kingsford and Pitt (1998) indicate that seine nets may increase the chance of bycatch, and is likely to result in damage to the product as well as damage and mortality of small non targeted jellyfish. EA would like to advise caution with the use of seine nets, and encourages comprehensive monitoring of their use.

Assessment

The jellyfish of commercial size are in the order of 30-40 cm in width and only one jellyfish can be dipped for at a time in order to ensure the bell is not damaged. The possibility of any bycatch, of undersized *C. mosaicus* and other jellyfish, is therefore minimal and if anything is caught it would be released immediately.

There may be some interaction with fish species using jellyfish as aggregating devices however the management plan does not allow the retention of any bycatch species. The risk of interaction being detrimental appears to be minimal, however an ongoing program of data collection on bycatch and the species role in the ecosystem will better inform future management and validate present assumptions.

Management response

Management arrangements for the fishery do not take into account the bycatch of other species, as it is assumed that the selectivity of the fishing method will result in minimal collection of species other than *C. mosaicus*. EA concurs that the use of hand dip-netting for harvest will minimise the probability of capturing other species.

The management plan states that bycatch of other jellyfish species will be monitored by the permit holder. Due to the current lack of knowledge about bycatch in the fishery EA encourages comprehensive collection of data about any bycatch activity. The use of occasional observers for compliance purposes will also assist in the reporting and validation of bycatch levels.

Conclusion

EA is confident that bycatch in the VJF will be minimal, however it is important that this assumption, stated in the management plan, is validated. EA therefore recommends that permit holders monitor and report on bycatch occurring within the fishery, and this information be analysed in the annual review on the ecological sustainability of the fishery.

Recommendation

- Permit holders to monitor and report on any bycatch activity in the fishery, and this information to be included in the analysis for the annual report on the ecological sustainability of the fishery.

Protected species and threatened ecological community protection

Objective 2: *‘The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities’*

Information requirements

EA has not been advised of any protected species interactions within the fishery since its development.

Permit holders are required to submit a fortnightly logbook that includes ‘observance of other species or other occurrences that reveal interactions with the environment’. The use of occasional observers for compliance purposes will also assist in the reporting and validation of interactions with protected species.

Assessment

The management plan states that the fishery will have minimal impact on the environment, as jellyfish tend to swim at the surface and leave little space for anything else. EA concurs that

the harvesting methods for the fishery are unlikely to have a significant impact on any protected species.

Turtles (particularly leatherback turtles) are known to prey on *C. mosaicus*. Leatherback turtles are known to occur in Victorian waters, although they are not common. While EA does not believe that the fishery would have a significant impact on the feeding activities of the turtle, caution is advised. It is of particular importance that the observance of, or interaction, with this species is reported and analysed in the annual review of the ecological sustainability of the fishery.

Management response

While significant impact on protected species in this fishery is not likely in the short to mid term, the continuation of research on *C. mosaicus* and its ecological position will further inform management of any potential interactions with protected species.

The management plan does not consider other potential impacts on protected species such as boat strike or ecosystem disturbance. At this early stage of development it is unlikely that the fishery will have a significant impact. The possible development into a commercial fishery may increase the likelihood of impact on protected species, however this will be considered if the fishery is to expand.

Conclusion

There are no threatened ecological communities associated with the VJF fishery and therefore these provisions in the Guidelines are not applicable.

Little information exists on the interaction of *C. mosaicus* and the VJF with protected species. To further inform management EA encourages NRE to continue the monitoring and reporting of interactions and observance of protected species and recommends that this is analysed as part of the review of the ecological sustainability of the fishery. Further research on *C. mosaicus* will also increase knowledge of the species interactions with any protected species, including leatherback turtles.

Recommendation

- The review of the ecological sustainability of the fishery to include the analysis of any reported interactions with, or observances of, protected species in the fishery.

Minimising ecological impacts of fishing operations

Objective 3: *‘The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally’*

Information requirements

Very little information exists on the ecological impacts of the VJF. The management plan states that the permit holder is required to report ‘observance of other species or other occurrences that reveal interactions with the environment.’ It is also stated that bycatch and benthic disturbance will be monitored by the permit holder to determine the suitability of the

fishing technology being used in the fishery. The use of occasional observers for compliance purposes will also assist in the reporting and validation of ecological impacts of the fishery.

Some study on the species and biomass estimates have been conducted for the fishery by MAFRI. NRE has advised EA that research will be conducted throughout the life of the plan to answer questions relating to ecosystem interdependence. The following areas have been identified in the management plan as research priorities with regard to the ecological impact of harvesting:

- Monitoring bycatch and reporting other species in areas of conglomeration;
- Investigate the diets of jellyfish and draw inferences as to the effects of jellyfish removal on populations of prey species; and
- Reproduction and polyp stage dynamics.

This research is to be completed by 2005 following the completion of the Developmental Fisheries Plan. The management plan states that annual update reports on these investigations will be produced and submitted to EA for consideration. EA views these research priorities as important to the management of the fishery and encourages research to also include investigation into species that prey on *C. mosaicus*.

Assessment

Jellyfish form an important part of the diet of a number of fish species and it is likely that its importance as a prey item is underestimated due to the difficulty of identifying jellyfish in the gut of animals. There is evidence suggesting that jellyfish act as fish attraction devices to juvenile finfish using aggregations for shelter. It has also been suggested that fish of the family Corangidae are attracted to the medusae, and the year class strength of some of these fish species can be affected by the numbers of medusae present.⁴ The loss of habitat for some species of juvenile fish could potentially change ecosystem structure and should be monitored.

The diet of *C. mosaicus* is poorly known. It is reported to feed on copepods, fish eggs and other planktonic organisms, and it is therefore thought that the removal of stock could have a positive effect on fish stocks. Further research into these effects should be conducted.

Additional potential environmental impacts of harvesting *C. mosaicus* may also include reduced input of nutrients from the natural decomposition of medusae.⁵ While the disposal at sea of ground tentacles may somewhat minimise this effect, this should be further investigated.

Management response

The management plan states that the current annual ecological review will include analysis of stock abundance, stock quality, processing quality and socio-economic implications. For a comprehensive look at the ecological sustainability of a fishery, EA believes it important that other aspects, such as bycatch, ecosystem impacts and protected species interactions are also incorporated in this review. The review has been mentioned throughout this report and the recommendations should achieve a more comprehensive annual review of the fishery.

⁴ Hay et al, 1990

⁵ Pitt, 1998

Further study of the target species biology will enhance knowledge of the ecological impact that removing the species will have on the ecosystem. It is important that before further development of the VJF, this information is collected so that management of the fishery can be based on a more informed position. EA recommends that these research projects be conducted in the next three years and regular progress updates submitted to EA.

To further inform management, EA recommends that an ecological impact investigation of the fishery be carried out in 2004. This investigation should incorporate all impacts of the fishery on the ecosystem in which the VJF operates, including disturbance, interaction, removal of jellyfish and pollution.

Conclusion

With little information existing on the ecological impact of the fishery it is important that further research is conducted. NRE has identified a number of priority research projects within their management plan and the license holder will be collecting valuable information to assist with this work. EA recommends that these projects be completed in the next three years and be reported on regularly to EA.

To further inform the ecological sustainable management of the VJF, EA recommends that an ecological impact investigation be carried out in 2004.

Recommendation

- The priority research projects identified in the management plan should be completed in the next three years. These include: the monitoring of bycatch and reporting of other species in areas of conglomeration; investigating the diet of jellyfish and drawing inferences as to the effects of jellyfish removal on populations of prey species; and reproduction and polyp stage dynamics. EA to be regularly updated on the progress of the research projects.
- An investigation of the ecological impact of the fishery to be carried out in 2004.

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LIST OF ACRONYMS

CPUE	Catch per unit effort
EA	Environment Australia
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
MAFRI	Marine and Freshwater Resources Institute
NRE	Victorian Department of Natural Resources and Environment
TADC	Total allowable developmental catch
VJF	Victorian Jellyfish Fishery