Arrow Squid Fishery (*Nototodarus gouldi*)

Overview of the fishery .

The Southern Squid Jig Fishery (SSJF) targets, and almost exclusively catches, arrow squid, *Nototodarus gouldi*. The fishery uses automatic jigging machines targeting 50-100m depth contours (jigs operate to a maximum depth of 120m). Little non-target catch occurs (Furlani *et al*., 2006c); bycatch species include barracouta, dusky shark, blue shark, shortfinned mako/blue pointer and garfish. Considerable quantities of squid are also taken by trawling in the Southern and Eastern Scalefish and Shark Fishery (SESSF) (McLoughlin 2006).

The SSJF is considered to be relatively lightly fished, although limited information is available pertaining to resource size (McLoughlin 2006). While the stock status is uncertain, a 2006 workshop convened by AFMA concluded that the impact of fishing was likely to be low. This is due to i) the wide distribution of squid relative to the area where fishing activity currently occurs; ii) the low level of catch as at 2007 relative to historical high levels; iii) the variable temporal CPUE pattern; iv) the squid's high fecundity and short life cycle; and v) ecosystem models estimating a very large squid biomass in the region, orders of magnitude greater than the level of catch.

Jigging occurs mostly out of two ports: Portland and Queenscliff in Victoria. Other ports, including Hobart (Tasmania) and Lakes Entrance (Victoria), are also fished sporadically based on squid availability. Fishing occurs out of the most economically viable ports given the squid population and location pulses. Given that the squid habitat is wide relative to the fishery (generally ranging across south eastern Australia), in some years localised fishing does not locate the squid pulses.

Current management of the fishery

Statutory Fishing Rights (SFRs) have been issued under the *Southern Squid Jig Fishery Management Plan 2005*. Once nominated to a boat, these SFRs authorise the holder to use a certain number of squid jigging machines during the year. The number of machines is determined by a Total Allowable Effort (TAE) limit, set annually.

These transferable gear SFRs are justified as an appropriate input control as the number of jigging machines determines the rate and quantity of squid that may be caught. Moon phase and weather conditions also help to regulate effort.

In January 2005, prior to the introduction of SFRs into the SSJF, there were 80 Commonwealth Southern Squid Jig Fishery Fishing Permits granted, these permits were replaced by 8000 SFRs in 2006. As at October 2007, there were 6400 SSJF SFRs: operators typically use 7-8 standard jigging machines per boat which requires (in 2007) the nomination of 70-80 SFRs per boat. Operators typically nominate SFRs to their boats in lots of 100 SFRs. Only 14 fishing permits were fished during 2004 (equivalent to 1400 SFRs or 140 standard jigging machines). The maximum number of active vessels over the last 10 years was 42 in 1996. There is a limited entry licensing agreement which acknowledges the duration of the fishery and latent effort while allowing scope for further development.

There is no Total Allowable Catch (TAC) or catch quota for the SSJF: a TAC is unable to be determined given the extent of biological data available. Currently there is insufficient scientific information available to set biological reference points for squid, although

preliminary biomass estimates from ecosystem models are orders of magnitude higher than catch. There is a 4,000 t catch trigger, which equates to half the highest historic annual catch by foreign squid fishing vessels off southern Australia.

An annual combined catch level trigger of 6,000 tonnes is currently in place for squid taken in the SSJF and the Southern and Eastern Scalefish and Shark Fishery (SESSF). This trigger provides for 4,000 tonnes from the SSJF and a combined allowance of 2,000 tonnes for the Great Australian Bight Trawl (GABT) and South East Trawl (SET) sectors of the SESSF. Under the current SSJF Management Plan, advice will be provided by a Southern Squid Jig Fishery Resource Advisory Group (SquidRAG) on an appropriate management response, should any of the trigger catch levels be reached. The current (as at 2007) combined catch is considerably less than historical high levels. Catch from jigging peaked at 1971 t in 1996-97, and was 1668 t in 2004-05. Squid catch from the SESSF trawl sectors, which can comprise more than half the total catch (40% of the total catch in 2006), peaked at 893t in 2002-03 and was 583 t in 2004-05. Catch rates are variable with no clear trends, and, based on available data, there is no evidence of within-season declines in catch-per-unit-effort (CPUE) (McLoughlin 2006).

Logbooks were introduced in 1986 to collect catch and effort information. Due to low effort levels, logbook data verification has not been considered necessary. There has been no routine recording of life-history parameters (e.g. reproductive size or stage) from landed squid. A catch-disposal system was introduced in 2004 to gather accurate data on squid landings for use in possible future TAC quota allocation. This data also provides means of validating logbook catch data. In addition, there have been extensive biological studies on age and growth, genetics, reproduction life history and distribution. Kate Stark's recent research with the University of Tasmania is of particular relevance.

Proxies against the Harvest Strategy Policy Reference Points

In the absence of biomass estimates from survey or stock assessment, in place of target and limit reference points, suites of precautionary intermediate and limit catch and effort triggers were defined based on recent catch history, with values well below historical high catch levels. These serve as checks against controlled expansion, whereby the limit trigger may not be revised higher without investing in a higher Tier level assessment, the results of which provide defensible justification for doing so. The intermediate trigger levels are not associated with "hard" decision rules to limit the fishery, but rather invoke data monitoring and/or analyses in order to better inform the fishery and potentially develop more robust triggers in light of improved understanding of its dynamics.

To mitigate against over-exploitation during periods of low availability, when self-regulation is not evident, there is an additional limit trigger based on effort and catch-per-unit-effort (CPUE).

General description of the harvest strategy

Fishery Issues; justification for approach

It is generally agreed that current catch levels of arrow squid in Commonwealth fisheries, as at 2007, are conservative: a 2006 AFMA workshop with world experts opined that the

current fishing effort was barely impacting squid populations. However, given the highly variable nature of squid populations and hence their availability (both in terms of abundance and location), managers have stated that a greater concern for a squid fishery is determining when availability of squid populations is low and avoiding overfishing at these times.

The proposed harvest strategy is designed to have minimal impact and costs if the fishery remains at its status quo (as at 2007), but to reach triggers invoking decision rules if the fishery escalates (e.g. as a result of market changes), or to detect possible overfishing when squid populations are low.

The harvest strategy will also enable the fishery to exploit and capitalize on a "boom" season – i.e. a season with high squid availability, where high take does not have an adverse effect on sustainability.

Stock structure has yet to be formally resolved, but the notion is that the fishery exploits a single stock with different cohorts becoming available locally within the range.

Given the current catches and the patchy distribution of both the squid and fishing activity, spatial closures were not explicitly considered at this stage of harvest strategy development.

Depletion analyses have been commonly used to undertake real-time stock assessments for squid fisheries worldwide (see for example Barton 2002 and Basson *et al.* 1996).

Harvest Strategy Overview

A system of real-time within-season management is proposed.

Suites of intermediate and limit catch and effort triggers were defined based on recent catch history, with values well below historical high catch levels. These serve as checks against controlled expansion, whereby the limit trigger may not be revised higher without investing in a higher Tier level assessment, the results of which provide defensible justification for doing so. The intermediate trigger levels are not associated with "hard" decision rules to limit the fishery, but rather invoke data monitoring and/or analyses in order to better inform the fishery and potentially develop more robust triggers in light of improved understanding of its dynamics.

Triggers for i) jig catch (intermediate and limit triggers), ii) jig effort (intermediate trigger), iii) combined jig and trawl catch (intermediate and limit triggers) and iv) combined Commonwealth trawl catch (limit trigger) are proposed, as follows:

1. Southern Squid Jig Fishery
    - Catch (2 trigger points):
        - i) 3000t intermediate trigger (this is a level that could be reached, for example during a boom)
        - ii) 5000t limit trigger
    - Effort: 30 standard vessel intermediate trigger (where a "standard vessel" equates to a vessel carrying SFRs equivalent to 10 standard squid jigging machines, noting that the average has generally been 7-8 jigging machines).

2. Combined Commonwealth Trawl sector fisheries (note this includes much more than the GAB and SET, even though at present (2007) the majority is caught only by those 2 sectors)
    - 2000t catch limit trigger
3. Combined jig and trawl triggers
    - Catch triggers
        i) 4000t combined intermediate trigger
        ii) 6000t combined limit trigger

Limit triggers may be overridden to enable industry to take advantage of "boom" seasons, during which the stock is highly unlikely to be adversely affected by the fleet fishing at full capacity. A "boom" is defined by the following "exceptional circumstance" criteria:

- Within <u>one lunar month</u>
    - The average CPUE of the <u>entire</u> jig fishery increases by twofold or greater;
        - (average CPUE to be calculated as month-specific, based on average CPUE for that month since January 1996 [the time at which a reliable catch and effort database was established])
        - N.B. as a general rule, average jig CPUE is 200kg/hour (this figure could potentially be used as a proxy in the absence of information – e.g. if a baseline CPUE is unavailable)
    - <u>AND</u> catch has been documented as occurring in the middle of the day <u>AND</u> irrespective of moon phase at night

To avoid over-exploitation during periods of low availability, the following criteria form an additional trigger:

- Effort is very high, defined as in excess of 45 boats (noting that the 30 boat trigger would have been reached in the interim, but that this decision rule is focused on a different objective and a more immediate response), but average CPUE per trip is low (<20% of long-term average), AND
- There is no evidence of high squid density elsewhere (across any and all fisheries, including state fisheries, i.e. whole-of-stock consideration, in terms of ad hoc checking of catches across the whole of the fishery and all of the sectors), AND
- There is no evidence of self-regulation within one month (as evidenced by "peripheral" vessels ceasing fishing within ~2 weeks of low catches occurring, quantitatively equated to effort decreasing to below 30 boats)

Response to the above triggers are described below, but generally the assessment approach is one of undertaking spatial and non-spatial depletion analyses, with a view to determining season length and/or total catch for the season.

Decision Rules (see subsequent section for annotated version with additional explanation and rationale)

- If the 3000t jig or 4000t combined catch trigger and/or the 30-vessel trigger are reached
    - hold a special Resource Assessment Group meeting involving members for the SSJF, SESSF and others as deemed necessary by AFMA
    - undertake full spatial (i.e. independent analyses specific to areas of localized fishing) AND non-spatial (whole fishery) depletion analyses (see below)
    - obtain additional biological information, in order to distinguish which cohort is being exploited (e.g. maturity, size, and age information – the latter via the collection of statoliths) [NB irrespective of trigger points, more rapid data uptake is recommended (e.g. real-time reporting) given the highly variable nature of the fishery. The implementation of electronic logbooks is strongly recommended in this context].
    - invest in research and development: implement a research program involving a full evaluation of monitoring data; evaluate pre-season or within-season management approaches and/or surveys. [Note that electronic logbook implementation can yield real-time data, facilitating within-season management].
    - if no indication of impact (depletion) (noting that this is best quantified in terms of numbers, as biomass will increase during the season due to growth), move on to next trigger
    - if evidence of impact, review the suitability and possibly revise trigger values
    - assess level of effort
- If the 5000t jig or 6000t combined catch trigger is reached,
    - TAC should not be increased until the fishery is reassessed using depletion analysis
    - An increase in TAC must be justified as being sustainable (in terms of depletion analysis)
    - hold a special Resource Assessment Group meeting involving members for the SSJF, and where the 6000t combined trigger is reached, members for the SESSF and others as deemed necessary by AFMA.
    - undertake a full spatial (i.e. independent analyses specific to areas of localized fishing) AND non-spatial (whole fishery) depletion analyses (see below)
    - increase monitoring [NB irrespective of trigger points, more rapid data uptake is recommended (e.g. real-time reporting) given the highly variable nature of the fishery]. Catch and effort levels should be monitored more closely (real-time spatially explicit data, by vessel if possible) after the second trigger has been reached, assuming that the depletion analysis reveals little or no evidence of depletion.
    - research and development
        - Implement pre-season/within-season management approaches and/or surveys

    - Based on results
        - No increase in catch unless can be demonstrated sustainable
        - If no indication of impact (depletion) retain and/or consider revised trigger
        - If evidence of impact consider cap in effort/catch

- If the 2000t trawl limit trigger is reached
    - hold a special Resource Assessment Group meeting involving members for the SESSF, and where the 6000t combined trigger is reached, members for the SESSF and others as deemed necessary by AFMA.
    - the same spatial depletion analysis by area as for the jig fishery is recommended.
    - Beyond this, trip limits could be set.
- If the criteria defining a "boom" period are met:
    - the limit trigger may be immediately overridden for that year, for the jig sector only.
    - This override will remain in place unless effort is very high, defined as in excess of 45 boats) and average CPUE per trip is low (<20% of long-term average)
        - Under these circumstances, if no catch triggers have been reached, the system of catch triggers will apply
        - If catch trigger levels have been exceeded, spatial closures are to be implemented in the area in which the "boom" is defined to have occurred.
- If the criteria defining high effort during periods of low availability are met:
    - Impose seasonal spatial closures (close areas where high effort is focused; redirect fishery to areas of potential higher density – based on some kind of analysis – e.g. trawl data, direct consultation with industry, past patterns of spatial catch)

Consistency with Harvest Strategy Policy

Providing real-time monitoring can be achieved (e.g. via electronic logbooks), the within-season monitoring against the suite of triggers facilitates the controlled expansion of the fishery with progressively highly data and analysis requirements. Once algorithms have been developed, depletion analyses provide a rapid means of assessing the fishery and responding in terms of revising season lengths and/or catch limits for that year.

If catches remain similar to 2007 levels it is assumed the fishery is not being overfished and that information and evaluation requirements are low. This is consistent with the outcomes of the 2006 AFMA-convened workshop at which it was concluded that recent effort levels were having a minimal impact on the stock. However, the precautionary triggers that have been put in place will detect expansion in the fishery if and when this occurs, with

intermediate triggers invoking analyses without placing immediate restrictions on fishing activities. While there are no direct limit reference points, the precautionary limit triggers preclude further catch or revision of this trigger unless shown by assessment (depletion analysis) that an increase in the limit is defensible.

Of key concern in terms of sustainability is determining when squid availability is low and avoiding overfishing at these times. The specific set of triggers dedicated to detecting this scenario will allow a rapid response to mitigate against localized depletion.

Given the highly variable nature of squid availability, the patchy distribution of squid, and the lack of biomass estimates, there is no absolute target reference point defined. The supposed minimal impact of current levels of effort on the stock would suggest that current (as at 2007) exploitation levels are well below that which would correspond to a theoretical B_{MEY} (noting that B_{MEY} is not a relevant reference point for this fishery given its high variability). The current (2007) low exploitation levels are associated with unfavourable market conditions. However, the suite of triggers allows for controlled expansion in a precautionary manner should market conditions improve, while an additional set of criteria form an "exceptional circumstance" trigger via which the limit triggers may be overridden (in a rapid and defensible manner) in the instance of a "boom", allowing for optimal exploitation during these times.

Annotated description of Triggers and Decision Rules (providing extra explanation and rationale), and additional Harvest Strategy details

General:

- Analysis of historic catch and effort data for the SSJF and SESSF trawl sectors should occur as a desktop study as an immediate priority. Given that a single stock is suspected, it is an explicit requirement that state fishery data and scientists be involved in this analysis. Trawl data must be included together with jig data. Analyses will also have to take into account the confounding effect imposed by market forces. Industry input should be sought as part of the analytical process.
- A SquidRAG to undertake annual assessments of catch and effort for all fisheries taking arrow squid in the Australian Exclusive Economic Zone including but not necessarily limited to the SSJF, SESSF, state managed fisheries and to seek industry input.
- Joint meetings to be held between SSJF and SESSF Resource Assessment Groups and any other groups as deemed necessary by AFMA.

Proposed trigger points:

- The current trigger points (4000t for jig [= half historic maximum catch]; 2000t for combined GABT and SET SESSF sectors), are not considered to meet the intent of the Harvest Strategy Policy (as jigging sector catch <<4000t; trawl sector <<2000t and unlikely to reach 2000t due to high net-mesh sizes used).

- The introduction of intermediate triggers, in addition to limit triggers invoking "hard" decision rules (such as closing the fishery until an assessment is completed) is recommended for both catch and effort
- The following trigger points are recommended (note that catch triggers refer to unprocessed product):

1. Southern Squid Jig Fishery
    - Catch (2 trigger points):
        iii) 3000t intermediate trigger (this is a level that could be reached, for example during a boom)
        iv) 5000t limit trigger
    - Effort: 30 standard vessel intermediate trigger (where a "standard vessel" equates to a vessel carrying SFRs equivalent to 10 standard squid jigging machines). The use of a "standard vessel" definition assigns a scale to the definition of a boat. This avoids ambiguities and/or loop holes such as larger boats with greater capacity.
2. Combined Commonwealth Trawl sector fisheries (note this includes much more than the GAB and SET, even though at present (2007) the majority is caught only by those 2 sectors)
    - 2000t catch limit trigger
3. Combined jig and trawl triggers
    - Catch triggers
        i) 4000t combined intermediate trigger
        ii) 6000t combined limit trigger

The combined triggers were proposed, since high total catches of squid can occur without the triggers for either the jig or trawl fishery being reached. For example, a 1500t trawl catch together with a 2500t jig catch is below the triggers for both sectors, and a 1500t trawl together with a 4500t jig catch is below the 6000t trawl and 5000t jig triggers. However, the high combined catches would warrant further investigation.

Considering effort triggers is important in the context of the lack of knowledge for the SSJF, and given the high amount of latent effort. As catch increases, so does effort due to increased availability. If there is a positive-linear trend for effort *versus* catch, a rough prediction of the amount of effort associated with a level of catch can be made. If this relationship does not hold, it is even more important to consider effort as an independent indicator.

Response (decision rule):

- If the 3000t jig or 4000t combined catch trigger and/or the 30-vessel trigger are reached
    - hold a special Resource Assessment Group meeting involving SSJF, SESSF and others as deemed necessary by AFMA

- undertake a full spatial (i.e. independent analyses specific to areas of localized fishing) AND non-spatial (whole fishery) depletion analyses
- implement increased monitoring to obtain additional biological information, in order to distinguish which cohort is being exploited (e.g. maturity, size, and age information – the latter via the collection of statoliths) [NB irrespective of trigger points, more rapid data uptake is recommended (e.g. real-time reporting) given the highly variable nature of the fishery. The implementation of electronic logbooks is strongly recommended in this context].
- invest in research and development: implement a research program involving a full evaluation of monitoring data; evaluate pre-season or within-season management approaches and/or surveys. [Note that electronic logbook implementation can yield real-time data, facilitating within-season management].
- if no indication of impact (depletion) (noting that this is best quantified in terms of numbers, as biomass will increase during the season due to growth), move on to next trigger
- if evidence of impact, review the suitability and possibly revise trigger values
- assess level of effort

- On basis of the results, a decision will be made regarding season length and/or total catch. A seasonal TAC of a maximum of 4000t may be set based on the projected total catch from depletion analysis. Note that this requires real-time monitoring.
- Spatially explicit analyses are important, since one area could be fished out for the season while others remain stable. Indeed, the fishery may ultimately move to spatial management by zone, while still considering the sustainability of the stock in its totality.
- Spatially explicit depletion analyses address the risk of hyperstability, by ensuring that catch rates are not being maintained due to the fleet moving. (Note, though, that there are currently no real concerns regarding localised depletion. Localised depletion can occur, but the stock is considered to be of low viscosity such that the depletion is temporary).
- Depletion analyses are conducted as follows: plot CPUE (for each day of the fishery, for the relevant sector) vs. cumulative catch (i.e. total season catch to date as at that day): (Figure 1) and, assuming linearity, extrapolate via linear regression to determine the projected i) catch and ii) length of season. The slope of the regression pertains to catchability. The response would be to limit the season or limit the total catch.
    - Potential problems:
    - linearity assumption: can often see exponential decline (Figure 1a). However, exponential, logarithmic or arc-sine transformations may be applied to the data so that they conform to this assumption.
    - growth is unpredictable
    - may see two separate linear sections if the stock has moved on (Figure 1b)

- quality of data
- CPUEs may increase through the season because of squid growing, hence CPUE in terms of numbers is preferable (or at least sub-samples of the catch to obtain a weight distribution and hence an approximation of CPUE in numbers)
- this approach assumes high steepness – squid may have lower steepness. More knowledge of squid biology is required in this context. However, this is an analysis technique that has been commonly applied to squid populations worldwide. Note that the retrospective depletion analyses will be informative as to the success or otherwise of the method in this fishery.

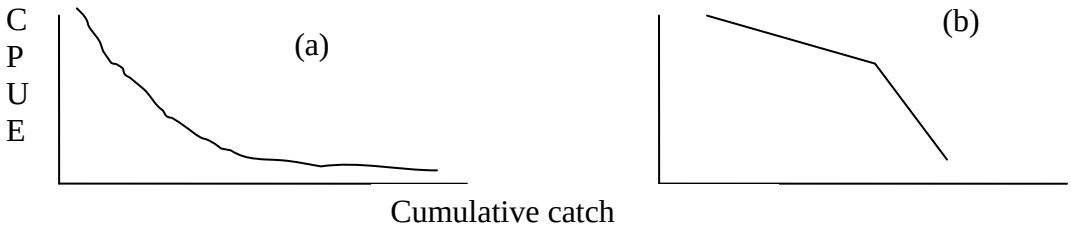

Figure 1 Illustration of two examples of depletion analysis

- If the 5000t jig or 6000t combined catch trigger is reached,
  - TAC should not be set above 5000t until the fishery is reassessed using depletion analysis
  - An increase in TAC must be justified as being sustainable (in terms of depletion analysis)
  - hold a special Resource Assessment Group meeting involving members for the SSJF, and where the 6000t combined trigger is reached, members for the SESSF and others as deemed necessary by AFMA.
  - undertake full spatial (i.e. independent analyses specific to areas of localized fishing) AND non-spatial (whole fishery) depletion analyses
  - implement increased monitoring [NB irrespective of trigger points, more rapid data uptake is recommended (e.g. real-time reporting) given the highly variable nature of the fishery]. Catch and effort levels should be monitored more closely (real-time spatially explicit data, by vessel if possible) after the second trigger has been reached, assuming that the depletion analysis reveals little or no evidence of depletion.
  -
  - research and development
    - Implement pre-season/within-season management approaches and/or surveys
  - Based on results
    - No increase in catch unless can be demonstrated sustainable
    - If no indication of impact (depletion) retain and/or consider revised trigger
    - If evidence of impact consider cap in effort/catch

Retrospective desktop study

As an explicit component of the harvest strategy, a research and development investment should be made to enable the analysis of historical data, in order to determine the geographic extent of the fishery and identify key factors (e.g. environmental) impacting the fishery: Moreover, it is important to establish protocols for CPUE standardization and depletion analyses so that these are in place prior to triggers being reached.

This study should aim to:

- undertake depletion analyses for previous years of historically high catches to evaluate the analysis technique (i.e. regression of projected catch compared to actual catch) and establish protocols for CPUE standardization and depletion analyses
- examine effort patterns in good vs. poor catch years
- investigate interseasonal spatial movements (to determine geographic extent and patchiness ultimately with a view to setting area definitions for depletion analysis and potentially spatial management.) It should be noted that the catch data on which this analysis will be based is not equivalent to an independent random survey: the jig sector actively targets squid while trawls catch squid incidentally but via coincidence with target finfish species.
- investigate effect of oceanography on squid population dynamics (potential Masters' project)

Following this retrospective study, the relevant management groups will reconvene and discuss the effectiveness of the method and define acceptable levels of uncertainty.

A recommendation for future development of the harvest strategy is to consider area-specific triggers (in addition to area-specific depletion analyses undertaken in response to triggers being reached). The retrospective catch and effort and spatial depletion analyses should attempt to identify within-season spatial patterns with a view to examining how spatially-specific triggers may be implemented. Although it is assumed a single stock is being exploited, different cohorts appear in different areas at different times. The rationale for area-specific triggers is to allow for separate management of individual cohorts. More specifically, this would mitigate against the situation where an additional patch/cohort of squid is encountered during a trip, but is unable to be fished, as doing so would result in a trigger being invoked as a result of previous catch from a separate cohort. Note, however, that criteria to determine spatially distinct cohorts will need to be developed – this may be informed by the retrospective study.

Multiple sector issue

Arrow squid caught by pelagic and demersal trawl methods must be explicitly considered in the harvest strategy, and a joint approach between the SSJF and the SESSF trawl RAGs is advocated. There could be allocation issues between these sectors, especially if triggers are reached. The issue of linking jig and trawl triggers and decision rules needs to be noted. It is not sensible if a trigger is reached for one fishery but not the other, especially as the Policy advocates stock management.

It should be noted that expected catch is not necessarily consistent across gear types. Trawling gear captures squid passively while jigging is an active fishing method (in that it

uses lights to attract squid). Thus non-feeding squid may be captured by trawl in areas where jigging is unsuccessful. Trawling does not generally target squid, but catches squid in the process of targeting other species. Jigging actively targets areas of high squid density.

Even in peak years, trawl catches are relatively low (<949t in 2006, <740t in 2005) and the temporal trend in catch has historically more stable than for jigging. However, if trawl gear parameters such as mesh sizes are changed, catches in squid catch levels may be expected to be reduced

- A 2000t catch limit trigger is suggested for the trawl sector (there is no point in having a trigger that is more than double the current catches). Note that this is a limit trigger, for the following reasons:
    - The trawl sectors generally do not target squid, but fish opportunistically
    - Trawls can actively avoid or target squid aggregations
    - Trawling activities have the potential to heavily impact on squid cohorts (although trawl catches of squid have been very low since the 1970s).
- If this trigger is reached, the same spatial depletion analysis by area as for the jig fishery is recommended. Beyond this, trip limits could be set.

Override of triggers in instances of a "boom" cohort (for the jig sector only)

In instances where a "boom" cohort occurs, the fishery should be able to override the above triggers in order to capitalize on the economic opportunity, given the scientific evidence that the impact of exploitation on a "boom" cohort is minimal. In order for an override of triggers to be effective and adequately precautionary, the exceptional circumstance of a "boom" must be able to be defined rapidly (i.e. a real-time evaluation so that it may be effectively exploited, given that it can occur within a 2-week window), and defensibly (so that the intent of the Policy is not undermined).

Given that a "boom" is characterized by a rapid increase in catch across the entire fleet, with catch occurring irrespective of time of day or moon phase, the following criteria shall be used to define a boom:

- Within one lunar month
    - The average CPUE of the entire jig fishery increases by twofold or greater;
        - (average CPUE to be calculated as month-specific, based on average CPUE for that month since January 1996 [the time at which a reliable catch and effort database was established])
        - N.B. as a general rule, average jig CPUE is 200kg/hour (this figure could potentially be used as a proxy in the absence of information – e.g. if a baseline CPUE is unavailable)
    - AND catch has been documented as occurring in the middle of the day AND irrespective of moon phase at night

If the above conditions are satisfied, the limit trigger may be immediately overridden for that year, for the jig sector only. The override does not apply to other sectors as squid are not the main target species of these sectors.

- This override will remain in place unless effort is very high, defined as in excess of 45 boats) and average CPUE per trip is low (<20% of long-term average)
    - Under these circumstances, if no catch triggers have been reached, the system of catch triggers will apply
    - If catch trigger levels have been exceeded, spatial closures are to be implemented in the area in which the "boom" is defined to have occurred.

If the fishery shows expansion without the "boom" criteria being met, the fishery will be subject to the suite of triggers described above. (Presumably, such expansion would occur as a direct result of market changes).

Avoiding over-exploitation via high effort in years of low availability

The fishery has the potential to negatively impact the stock when high effort is applied in years of low availability. While this is a rare scenario, it is one that may occur following market changes and/or a "boom" year, and must be mitigated against. The above suite of triggers does not explicitly encompass/detect a scenario where effort is high but catch rates are low. While depletion analysis should detect a reduction in availability, this analysis is not undertaken unless one of the above triggers is invoked.

A trigger and decision rule for this scenario are as follows:

If

- Effort is very high, defined as in excess of 45 boats (noting that the 30 boat trigger would have been reached in the interim, but that this decision rule is focused on a different objective and a more immediate response), but average CPUE per trip is low (<20% of long-term average), AND
- There is no evidence of high squid density elsewhere (across any and all fisheries, including state fisheries, i.e. whole-of-stock consideration, in terms of ad hoc checking of catches across the whole of the fishery and all of the sectors), AND
- There is no evidence of self-regulation within one month (as evidenced by "peripheral" vessels ceasing fishing within ~2 weeks of low catches occurring, quantitatively equated to effort decreasing to below 30 boats).

Then

- Impose seasonal spatial closures (close areas where high effort is focused; redirect fishery to areas of potential higher density)

Note that other decision rule options were considered, but were dismissed as impractical or not sensible. Reducing the number of boats or machines was considered too slow and difficult to implement effectively, and a means that would limit industry without directly addressing the main issue of local vulnerability. Attempting to reduce the catch per boat would be almost impossible as catches are so highly variable.

Process for review

The desktop analysis of historical data will provide insight into the performance of depletion analysis in the context of the Arrow Squid Fishery. As part of the review process, any problems arising with the violation of assumptions underpinning depletion analyses should be more specifically addressed if these are compromising the performance of the assessment. Acceptable levels of uncertainty should be defined. Additionally, appropriate CPUE analyses (e.g. via generalized linear modelling approaches) should be undertaken to provide standardized CPUEs as input to the depletion analyses.

The success of the harvest strategy is highly dependent on the ability to implement real-time monitoring and a rapid analysis and management action in response to triggers being met. The practical implementation of this should be assessed as part of the formal review process.

The practical performance of the strategy should be evaluated via consultation with industry and scientists. For example, if triggers are being met, consideration should be given to how this has occurred – was it associated with catch taken from a single area? Or combined catches across various areas? This is important in the context of considering the potential value of moving to area-specific triggers.

Close attention must be paid to the performance of the strategy in the "exceptional" circumstance of a boom and the instance when localized depletion may occur due to high effort in times of low availability. Evaluating whether the harvest strategy is robust and performing as anticipated is particularly important in these more extreme circumstances.

Some of the responses/decision rules in response to trigger levels being reached are somewhat vague and consideration should be given to the details. For example, "implementing increased monitoring" is an appropriate response to a trigger level being reached, but the nature and extent of the monitoring will depend on the GVP and available external funding/resources.

Ultimately, consideration should be given to defining limit and target reference points that are more closely aligned with the Policy. The nature of these will depend on the evolving status of the fishery: reference points may remain based on catch if the fishery was still information-poor, or on biomass estimates if sufficient analyses have been undertaken.

There are no sustainability estimates for the fishery, but a review of other squid fisheries globally could be undertaken as part of the review process.

A more formal review of the performance of the strategy could be reasonably readily facilitated using software such as the Atlantis software developed by Beth Fulton (which, as at 2007, stands at the most sophisticated tool currently available) Squid are already included as a "low resolution" fishery in the ecosystem model and the details against the fishery could therefore readily be included.

Consultation with the relevant Management Advisory Committee(s) for the Southern and Eastern Scalefish and Shark Fishery trawl sectors is required before this harvest strategy can be finalized. While industry representatives from the Great Australian Bight Trawl and South East Trawl sectors of the SESSF have been invited to SquidRAG meetings to be involved in harvest strategy development, none have been able to attend as at October 2007.