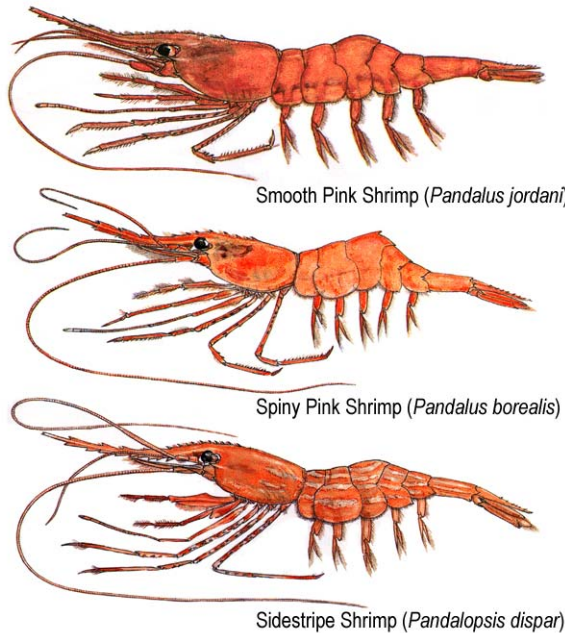




ASSESSMENT OF INSHORE SHRIMP STOCKS ALONG THE COAST OF BRITISH COLUMBIA



Drawings by A. Denbigh

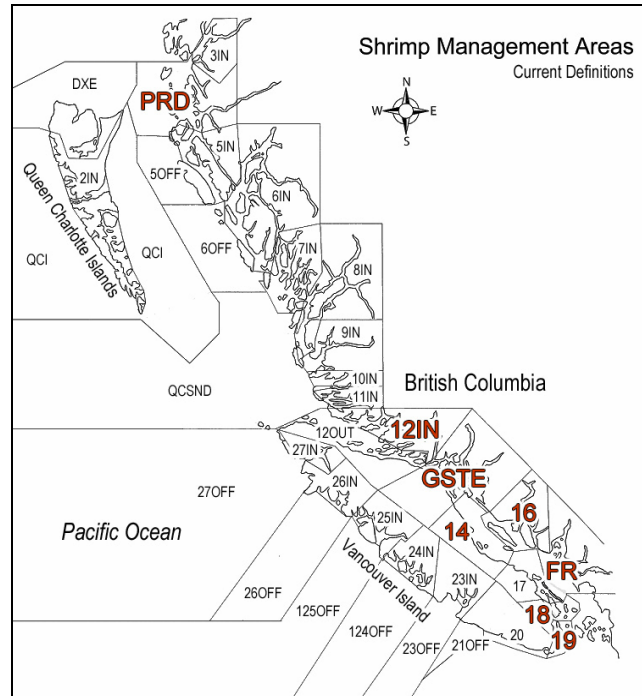


Figure 1: Shrimp management areas (SMA's) along the coast of British Columbia. SMA's highlighted in red font are addressed in this report

Context:

Prior to 1996, the shrimp trawl fishery along the coast of British Columbia was generally open year-round with no catch limitations. The fishery exploits primarily two species of pink shrimp (*Pandalus jordani* and *P. borealis*) and sidestripe shrimp (*Pandalopsis dispar*). Starting in 1995, effort increased sharply with corresponding unprecedented harvest and movement of the fleet into areas that were not historically fished. In response to this increase, significant changes in the management and assessment of shrimp stocks were implemented commencing in 1997. These changes included the development and implementation of an assessment program similar to an established West Coast Vancouver Island shrimp assessment program that utilizes swept-area fishery independent trawl surveys to index shrimp biomass (Boutillier et al. 1999; Martel et al. 2000). Shrimp Management Areas (SMA's) and area catch ceilings were also established along the entire coast of British Columbia (Fig 1).

The status of British Columbia inshore shrimp stocks, as indexed through annual surveys, forms the biological basis upon which the Department of Fisheries and Oceans (DFO) Fisheries and Aquaculture Management branch sets annual area catch ceilings, referred to in this report as total allowable catch (TAC). In addition, in 2009 DFO implemented provisional Precautionary Approach (PA) harvest control rules (HCR) for shrimp stocks (DFO 2009).

This report provides a summary of shrimp stock trends, as indexed through surveys, from inception of surveys in 1997 to 2010, along with commercial catch trends from 1987 to 2010. Commencing in 2010,

at the request of Fisheries and Aquaculture Management (FAM), confidence intervals (95% CI) for the estimated shrimp biomass indices are reported. This report does not provide new advice on shrimp stock status but rather documents the advice on stock status which has previously been provided to fishery managers and industry in-season.

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Pacific Regional Advisory Meeting. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at <http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm>.

SUMMARY

- The coast of British Columbia is assessed and managed as 36 Shrimp Management Areas (SMA's).
- Shrimp stock size is indexed through annual swept-area fishery independent surveys in selected SMA's.
- The current assessment concludes that shrimp stocks show high annual variation in stock size.
- In 2010, 12 of the 16 shrimp stocks assessed in this report were above the Upper Stock Reference (USR) and in the Healthy zone; two stocks, SMA 18 and SMA 19 sidestripe shrimp, were between the USR and Limit Reference Point (LRP) and in the Cautious zone; two stocks, SMA 18 and SMA 19 pink shrimp, were below the LRP and in the Critical zone.
- Annual TACs were reached in some SMA's in some years between 1998 and 2010; however, catch ceilings have never been reached in all SMA's in a single year.

INTRODUCTION

Species Biology

The biology of shrimp is unique in that they start their life as males and then undergo a sex change in mid-life to become females. This sex change results in the largest size class being comprised of females. Shrimp reproduce only once in a lifetime. Mating occurs in the fall and females carry developing eggs externally on their abdomen from October to March. Eggs hatch in late March to early April. Larvae are planktonic prior to settling on the ocean floor. The maximum age for most of the commercially exploited shrimp species in British Columbia is four years.

The Fishery

The British Columbia shrimp trawl fishery is a limited entry fishery that currently has 248 eligible licences. However, there has been a sharp decline in active commercial licences from a peak of 222 in 1996 to 57 in 2009. The shrimp trawl fishery primarily targets pink shrimp (*Pandalus jordani* and *P. borealis*) and sidestripe shrimp (*Pandalopsis dispar*). Two gear types are

permitted: otter trawl and beam trawl. Beam trawl is currently the most prevalent gear type in use with 62% of active vessels employing beam trawl gear in 2009.

The fishery is managed by SMA to species-specific TACs which are set annually. For index sites TACs are based on the biomass index derived from fishery independent surveys; for non-index sites arbitrary TACs are used. The implementation of TACs occurred in 1997 in all SMA's with the exception of the offshore areas that had seasonal openings that were subsequently replaced by TACs in 2002.

ASSESSMENT

Status of shrimp stocks along the coast of British Columbia is assessed through fishery independent surveys designed to index shrimp biomass in selected SMA's. Stock status of shrimp stocks in SMA's 18/19, FR (Fraser River), 14, 16, GSTE (Georgia Straight East), 12IN (Inshore), and PRD (Prince Rupert District) is discussed and presented in this report along with trends in catch and annual TACs (Figure 1). Stock status of the offshore shrimp stocks is not included in this report. Although precautionary approach (PA) compliant provisional reference points were only established in 2009 and implemented into the harvest control rule (HCR) in 2010, stock trends from 1997 to 2010 are discussed in relation to the upper stock reference (USR) and limit reference point (LRP) and stock status zones (DFO 2009). The Healthy zone is stock size above the USR, Cautious zone between the USR and LRP, and Critical zone below the LRP.

SMA 18/19

SMA 18 and 19 were assessed and managed as two distinct SMA's from 1998 to 2006. Commencing in 2007, SMA 18 and 19 were combined for management purposes but the areas continue to be assessed separately.

The SMA 18 pink shrimp biomass index has been variable. A record high biomass was observed in 2008 followed by a decreasing trend. The 2010 pink shrimp biomass index is the lowest observed since surveys began and is now well below the LRP and in the critical zone.

The sidestripe shrimp biomass index in SMA 18 has been variable, reaching a record high in 2006. Since 2006 a decreasing trend has been observed and the 2010 sidestripe shrimp biomass index is below the USR and in the Cautious zone.

The SMA 19 shrimp biomass index has been at low levels from 2006 to 2010 relative to the 1998 to 2002 period. The 2010 biomass index is below the LRP and in the Critical zone.

The sidestripe shrimp biomass index in SMA 19 has been at low levels from 2007 to 2010 relative to the 1999 to 2002 period. The 2010 sidestripe shrimp biomass index is below the USR and in the Cautious zone.

The pink shrimp stocks in SMA 18 and 19 are both below the LRP and in the Critical zone as defined by the PA. In addition, the sidestripe shrimp stocks in SMA 18 and 19 are both below the USR and in the Cautious zone. As a result of the 2010 status of these stocks there will be no directed pink or sidestripe shrimp harvest in these management areas in 2010.

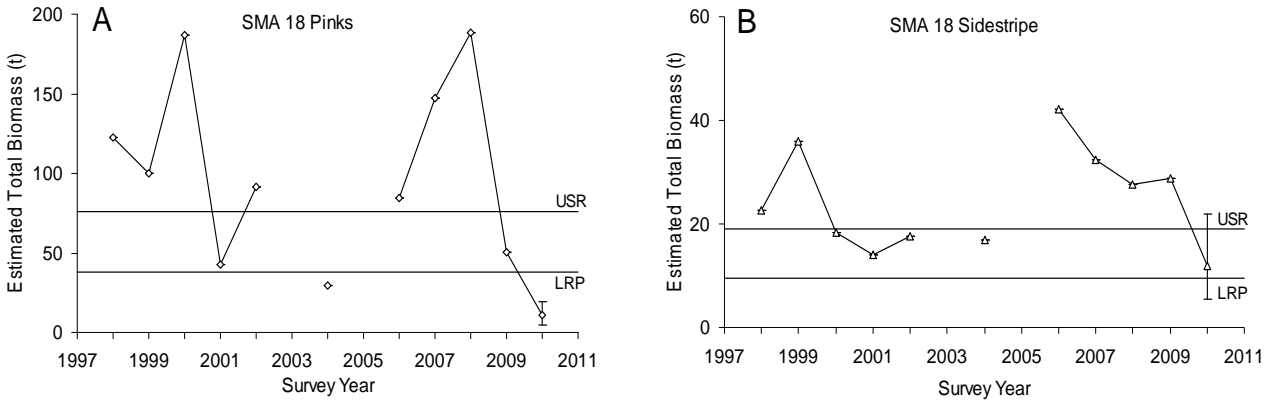


Figure 2. Trend in pink shrimp (A) and sidestripe shrimp (B) biomass in SMA 18, 1998-2010.

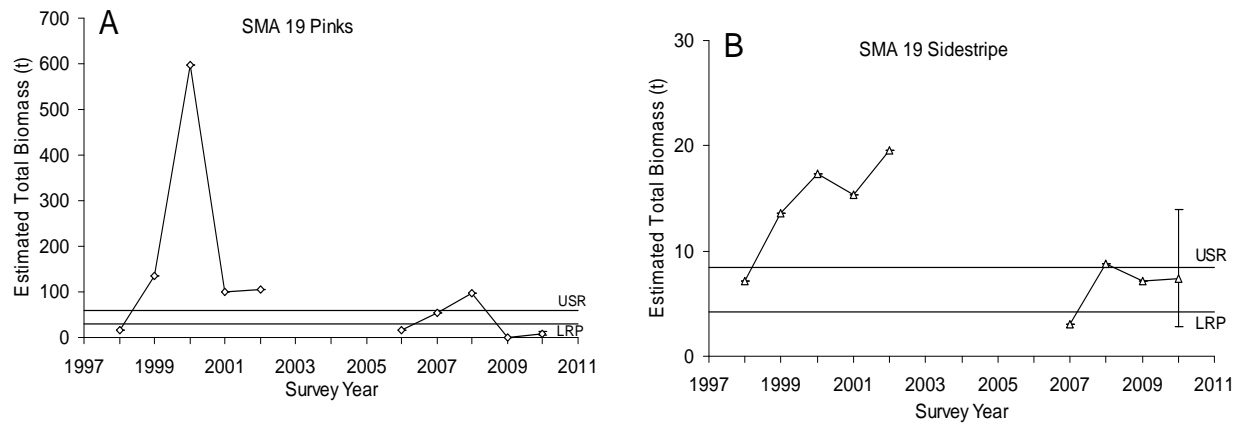


Figure 3. Trend in pink shrimp (A) and sidestripe shrimp (B) biomass in SMA 19, 1998-2010.

As noted earlier, SMA 18 and 19 were managed as two distinct SMA's from 1998 to 2006. During this period TACs were reached for at least one of the species in both SMA 18 and SMA 19 in all years. These two areas were then combined commencing in 2007. For this report, we present the combined landings from the two areas but only report annual TACs commencing in 2007. The catch ceiling for sidestripe shrimp was reached in 2007 and 2008. TACs were not reached in 2009

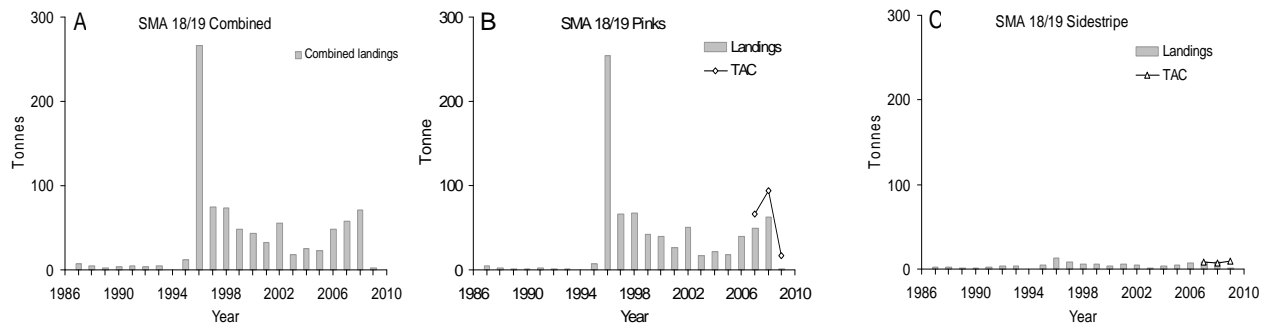


Figure 4. Annual total catch of pink and sidestripe shrimp combined (A), pink shrimp only (B), sidestripe shrimp only (C) and respective TACs for SMA 18 and 19 combined.

SMA FR (Fraser River)

The SMA FR pink shrimp biomass index has been variable. Biomass was relatively high from 1998 to 2000, followed by a period of low biomass from 2002 to 2005 which was below the USR and in the Cautious zone. The 2006 and 2007 biomass index was at the USR; this was followed by an increasing trend to 2009. The 2010 pink shrimp biomass index is a decline from 2009, but the stock remains above the USR and in the Healthy zone

The sidestripe shrimp biomass index was relatively stable from 1998 to 2007 and fluctuated around the USR. An increasing trend has been observed since 2007, and the stock is well above the USR and in the Healthy zone.

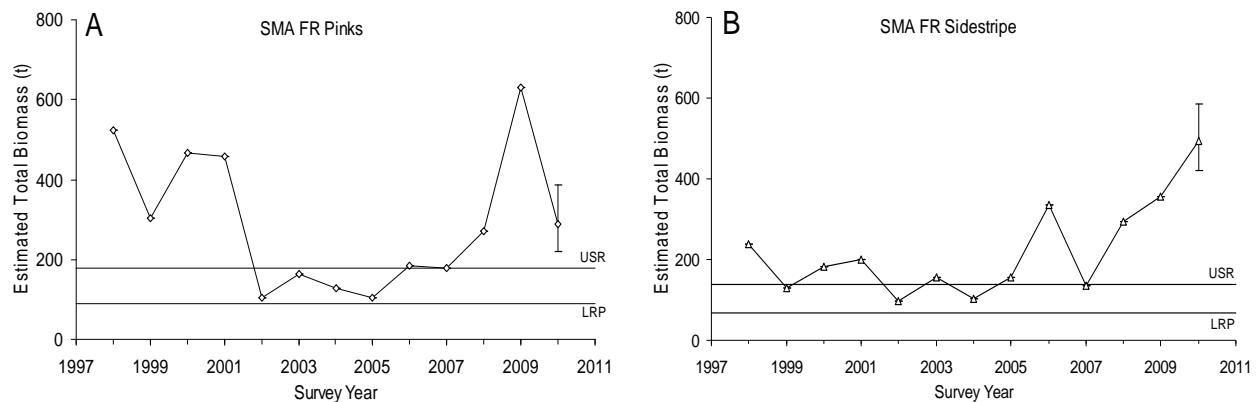


Figure 5. Trend in pink shrimp (A) and sidestripe shrimp (B) biomass in SMA FR, 1998-2010

Annual TACs based on survey results have been in place for SMA FR since 1998; however, from 1998 to 2002 a combined catch ceiling for pinks and sidestripe shrimp was used. Commencing in 2003 the combined catch ceiling for pink and sidestripe shrimp was separated. From 1998 to 2002, the combined period, TACs were reached in every year except for 1998. From 2003 to 2008 TACs were reached for pink shrimp in every year and for sidestripe shrimp in 2005 only. TACs were not reached in 2009 due to high biomass.

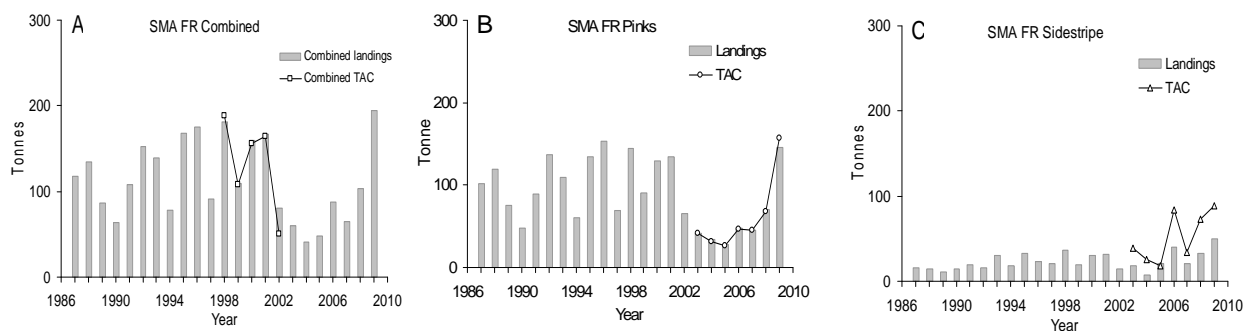


Figure 6. Annual total catch of pink and sidestripe shrimp combined (A), pink shrimp only (B), sidestripe shrimp only (C) and respective TACs for SMA FR.

SMA 14

The SMA 14 pink shrimp biomass index has been variable with the index dropping below the USR in three of 12 years, with one of those years (2005) below the LRP. The 2010 pink shrimp

biomass index declined from 2009 but the stock remains above the USR and in the Healthy zone.

The sidestripe shrimp biomass index was below the USR and in the cautious zone from 1998 to 2001; this was followed by an increasing trend. The sidestripe shrimp biomass index has remained above the USR in all subsequent years since 2001 except for 2005. A continuing increasing trend has been observed since 2005 with the biomass index in the Healthy zone.

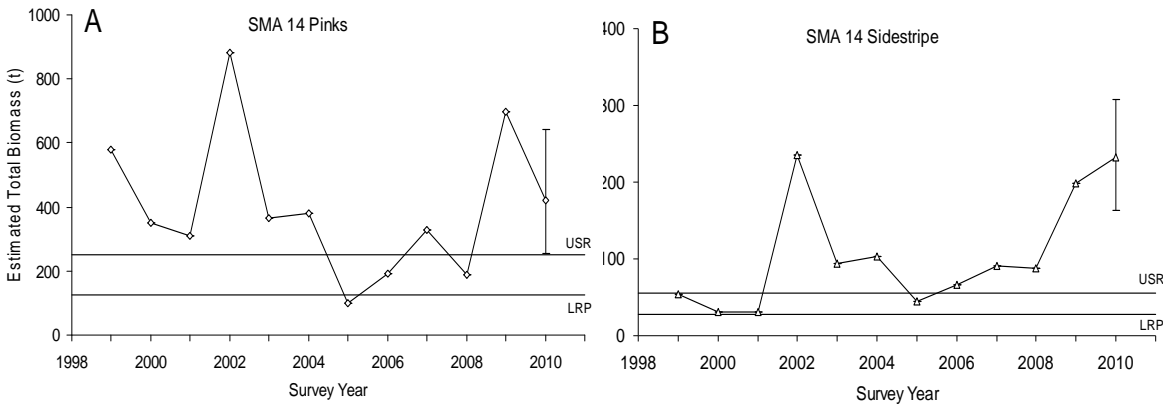


Figure 7. Trend in pink shrimp (A) and sidestripe shrimp (B) biomass in SMA 14, 1999-2010

Annual TACs based on survey results have been in place for SMA 14 since 1999; however, from 1999 to 2002 a combined catch ceiling for pink and sidestripe shrimp was used. Commencing in 2003, the combined catch ceiling for pink and sidestripe shrimp was separated. From 1999 to 2002, the combined period, TACs were reached in 2000 and 2001. From 2003 to 2009 TACs were reached for pink shrimp in 2005 and 2006.

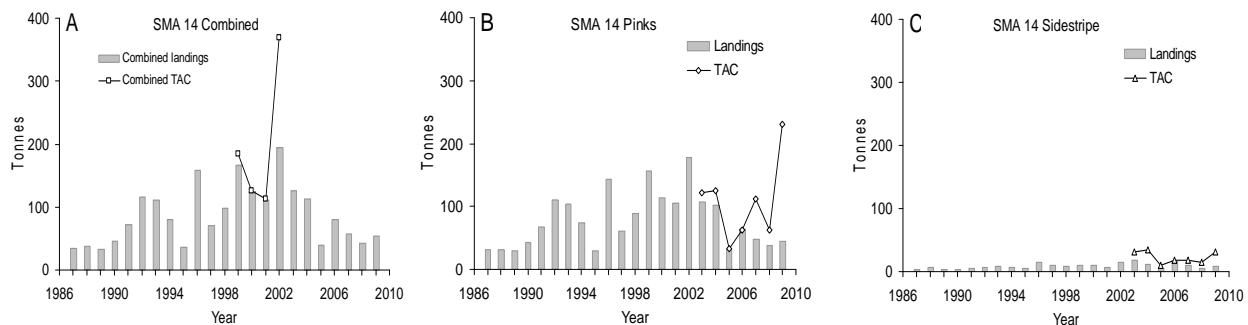


Figure 8. Annual total catch of pink and sidestripe shrimp combined (A), pink shrimp only (B), sidestripe shrimp only (C) and respective TACs for SMA 14.

SMA 16

The SMA 16 pink shrimp biomass index was relatively stable from 1998 to 2004 and above the USR. No estimates of pink shrimp biomass are available for 2005 and 2006. The 2007 biomass index was near the USR, but in the Cautious zone. Pink shrimp biomass increased to the USR in 2008 and above the USR to the Healthy zone 2009. The 2010 pink shrimp biomass index declined in 2010 but the stock remains above the USR and in the Healthy zone.

The sidestripe shrimp biomass index generally followed the same trend as pink shrimp from 1999 to 2008; however, in 2009 a decrease in sidestripe shrimp biomass was observed. In

marked contrast to pink shrimp, the sidestripe biomass increased in 2010 to near historic high levels and is in the Healthy zone.

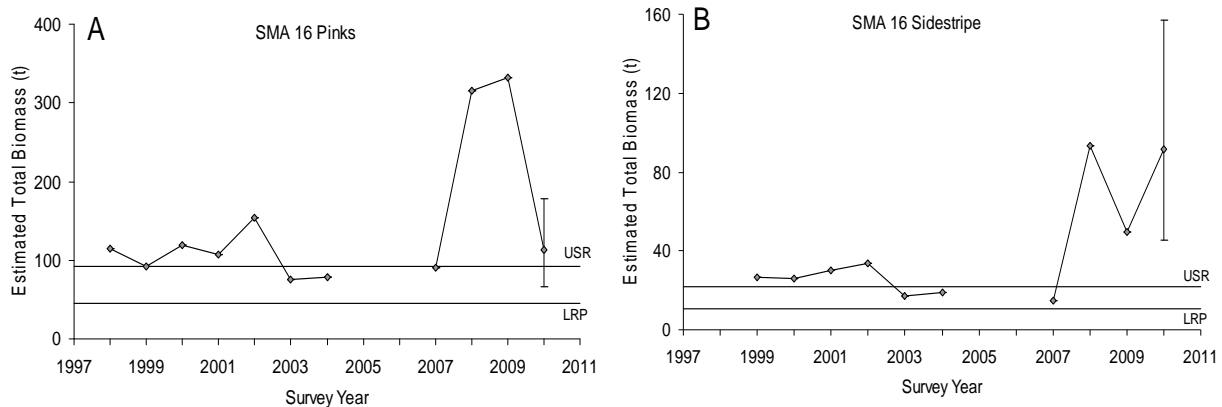


Figure 9. Trend in pink shrimp (A) and sidestripe shrimp (B) biomass in SMA 16, 1998-2010

Annual TACs based on survey results have been in place for SMA 16 since 1998; however, from 1998 to 2002 a combined catch ceiling for pink and sidestripe shrimp was used. Commencing in 2003, the combined catch ceiling for pink and sidestripe shrimp was separated. From 1998 to 2002, the combined period, the catch ceiling was reached in only one year (1999). From 2003 to 2010 TACs were reached for pink shrimp in 2005 and 2006 and for sidestripe shrimp in 2007.

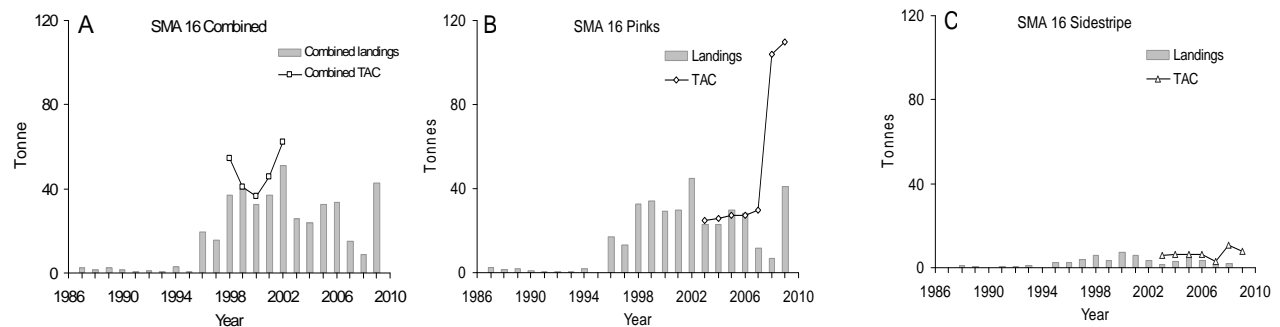


Figure 10. Annual total catch of pink and sidestripe shrimp combined (A), pink shrimp only (B), sidestripe shrimp only (C) and respective TACs for SMA 16.

SMA GSTE (Georgia Strait East)

The SMA GSTE pink shrimp biomass index has been highly variable. Pink shrimp biomass has been below the USR in four of the 11 years that estimates are available. However, the 2010 pink shrimp biomass index is above the USR and in the Healthy zone.

The sidestripe shrimp biomass index was variable between 1999 and 2004. A continual increasing trend in sidestripe shrimp biomass has been observed from 2007 to 2010. The 2010 sidestripe biomass index is a record high and well above the USR and in the Healthy zone.

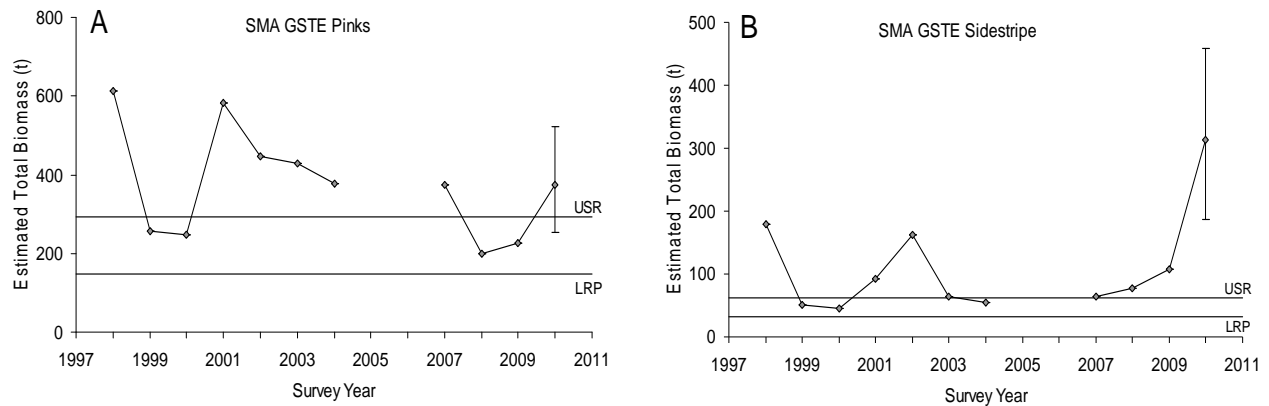


Figure 11. Trend in pink shrimp (A) and sidestripe shrimp (B) biomass in SMA GSTE, 1998-2010

Annual TACs based on survey results have been in place for SMA GSTE since 1998; however, from 1998 to 2001 a combined TACs for pink and sidestripe shrimp was used. Commencing in 2002 the catch ceiling for pink and sidestripe shrimp was separated. From 1998 to 2002, the combined period, TACs were reached in 1999 and 2001. From 2002 to 2009 TACs were not reached, except for pink shrimp in 2004.

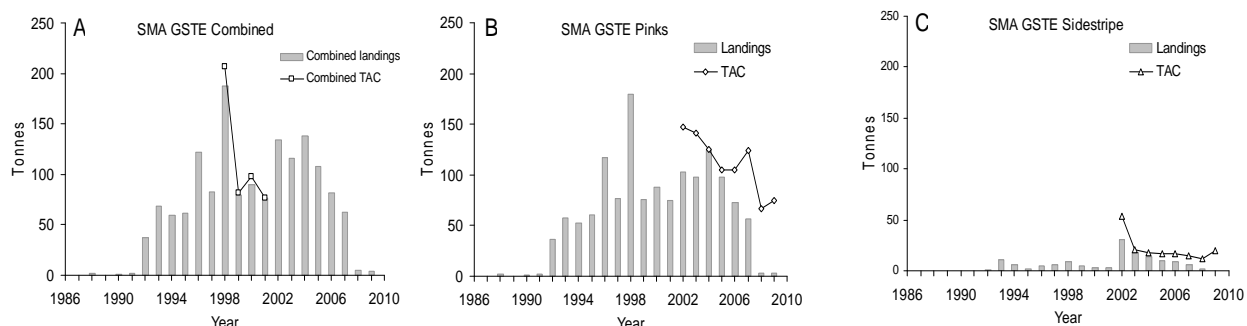


Figure 12. Annual total catch of pink and sidestripe shrimp combined (A), pink shrimp only (B), sidestripe shrimp only (C) and respective TACs for SMA GSTE.

SMA 12IN (Inshore)

The fishery independent survey area in SMA 12IN has changed over time. Surveys were initiated in 1998, but commencing in 2005, the survey area was significantly reduced. The reduced area, known as Pacific Fishery Management Area (PFMA) 12-26 was surveyed annually from 2005 to 2010. For development of reference points, and continuity in presenting stock status trends, survey data from PFMA 12-26 were extracted from the 1998 to 2004 survey data. Therefore, all stock trend data presented in this report for SMA 12IN includes only the PFMA 12-26 portion of the area. In contrast, the commercial catch data and catch ceiling data presented in this report are for all of SMA 12IN, not just the PFMA 12-26 portion.

The SMA 12IN pink shrimp biomass index from 1998 to 2002 was relatively stable but below the USR and in the Cautious zone. Since 2002 the stock has been highly variable and above the USR and in the Healthy zone.

The sidestripe shrimp biomass index has shown an increasing trend from a low in 1998 to a record high in 2010. The 2010 sidestripe biomass index is well above the USR and in the Healthy zone.

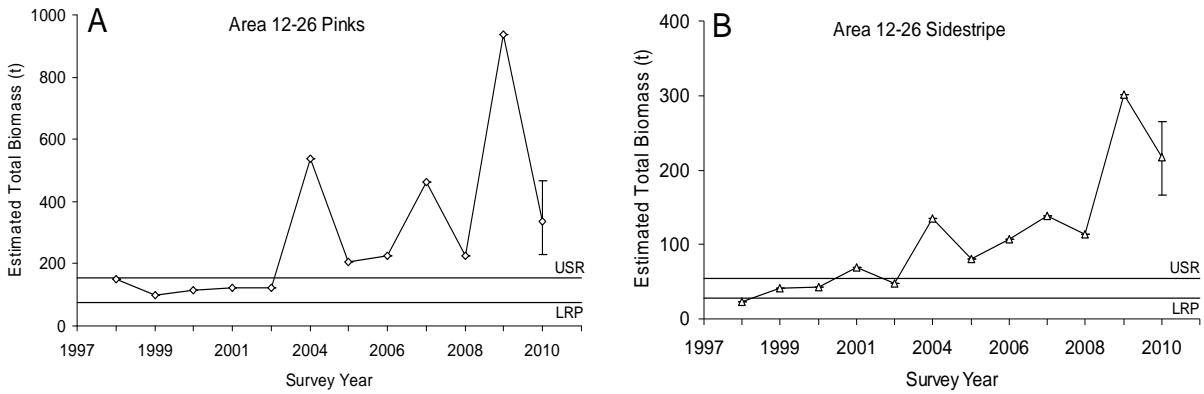


Figure 13. Trend in pink shrimp (A) and sidestripe shrimp (B) biomass in SMA 12-26, 1998-2010

Annual TACs, based on survey results for 12IN, have been in place since 1998, however for 1998 and 1999 a combined catch ceiling for pink shrimp and sidestripe shrimp was used. Commencing in 2000 the catch ceiling for pink and sidestripe shrimp was separated. During the combined catch ceiling period the catch ceiling was reached in 1999. From 2000 to 2009 the TACs for both pink shrimp and sidestripe shrimp were reached in 2003 and for pinks only in 2005.

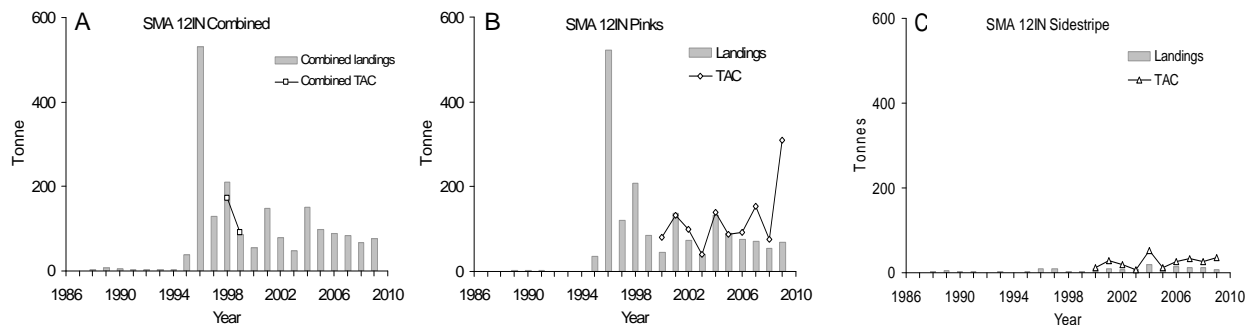


Figure 14. Annual total catch of pink and sidestripe shrimp combined (A), pink shrimp only (B), sidestripe shrimp only (C) and respective TACs for SMA 12.

SMA PRD (Prince Rupert District)

The SMA PRD pink shrimp biomass index was variable between 1998 and 2004 and fluctuated above and below the USR. From 2005 to 2010 the stock has remained above the USR and in the Healthy zone.

The sidestripe shrimp biomass index was relatively stable from 1998 to 2004, falling below the USR in only two years. A general increasing trend has been observed since 2005. The 2010 biomass index is a record high, well above the USR and in the Healthy zone.

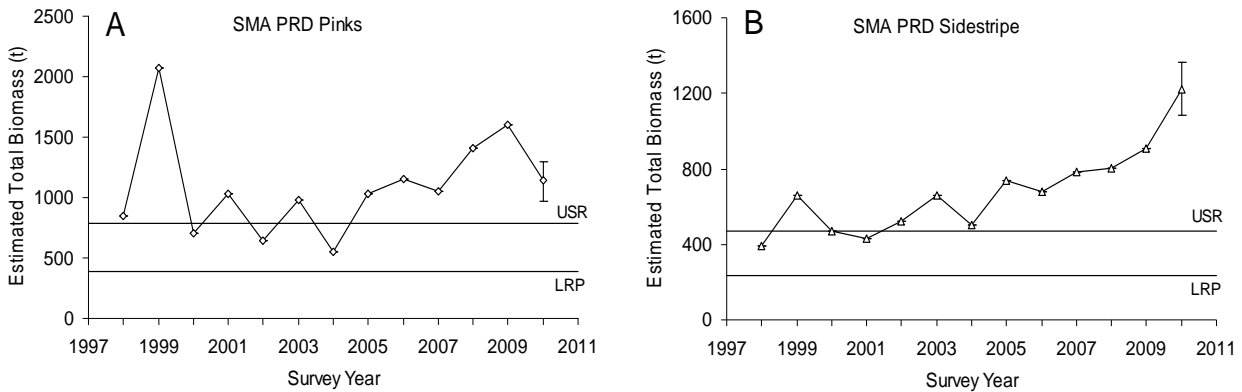


Figure 15. Trend in pink shrimp (A) and sidestripe shrimp (B) biomass in SMA PRD, 1998-2010

Annual TACs based on survey results have been in place since for SMA PRD 1998 but these have never been reached.

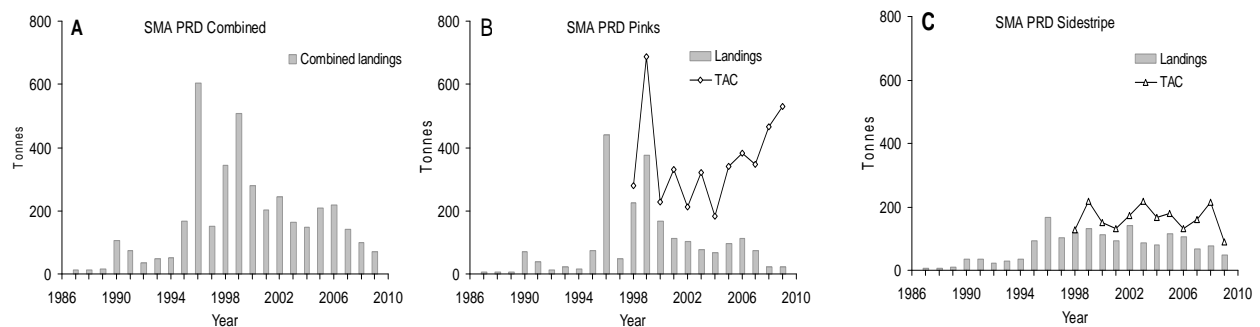


Figure 16. Annual total catch of pink and sidestripe shrimp combined (A), pink shrimp only (B), sidestripe shrimp only (C) and respective TACs for SMA PRD.

Ecosystem Considerations

The most pressing ecosystem issues concerning the harvest of shrimp and the shrimp trawl fishery are bycatch, benthic impacts and exploitation of forage fish species. A bycatch monitoring program is in place for the shrimp trawl fishery. Estimates of bycatch by tow are available for trips that are observed; however, coverage is very low which precludes the ability to estimate total annual bycatch by the fishery.

The potential impacts of mobile bottom trawl gear on benthic habitat, populations and communities has been well documented (DFO 2006). The shrimp trawl fishery off the coast of British Columbia tends to fish in high energy, soft bottom environments which are more robust to benthic alteration by trawl gear than complex, high structure substrate.

Shrimp are identified as a forage fish and are subject to DFO's forage fish policy. The actual role of shrimp as a forage fish in the ecosystem is not quantified.

CONCLUSIONS

Shrimp biomass is highly variable within and between SMA's. In 2010, twelve of the sixteen shrimp stocks assessed were above the USR and in the Healthy zone; two stocks, SMA 18 and SMA 19 sidestripe shrimp, were between the USR and LRP and in the Cautious zone; two stocks, SMA 18 and SMA 19 pink shrimp, were below the LRP and in the Critical zone.

Since the start of surveys in 1997 following the significant increase in fishing in 1995, annual TACs were reached in some SMA's in some years between 1998 and 2010; however, TACs have never been reached in all SMA's in a single year.

SOURCES OF INFORMATION

This Science Advisory Report has resulted from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Pacific Regional Advisory Meeting of November 30 – December 2, 2010 on Pacific Invertebrate SubCommittee Meeting: Pink and Spiny Scallop, Sea Cucumber, Central Coast Manila Clam, Geoduck Clam Aquaculture, and Shrimp Trawl. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at <http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm>.

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