# Experimental assessment of constraints for King George whiting (*Sillaginodes punctata*) recruitment in Gulf St Vincent, South Australia

Thesis submitted by

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# ABSTRACT

King George whiting *Sillaginodes punctata* (KGW) is one of South Australia's most valuable finfish species highly targeted by commercial and recreational fishers. The response of this species to both anthropogenic and climate changes is currently unknown and may impact on recruitment success. This thesis examined four key areas potentially influencing the recruitment success of KGW in relation to current and future environmental changes. The specific aims were:

- to investigate the molecular response of KGW to acute and extended changes in temperature by examining the production of heat shock proteins.
- to reveal the osmoregulatory ability of KGW by looking at blood plasma ion concentrations, and to assess if current high salinity levels in the gulfs are impacting growth and survival of young recruits.
- to identify the influence of light intensity in regulating growth, survival, behaviour and body colouration.
- to study the dietary interactions of young of the year recruits with estuarine opportunists and permanent resident fish species.

Heat shock proteins (HSP) play an important role in protein folding and cytoprotection. Members of the HSP70 family are sensitive and readily produced in response to thermal stress in many fish species thus serve as a useful stress bio-indicator. KGW inhabit inshore shallow waters as juveniles and are subject to considerable thermal variance before migrating to deeper water towards maturity. Two experiments were conducted to test the hypothesis that whiting approaching

sexual maturity exhibit a decrease in HSP production and that exposure to high temperatures provokes HSP production in juvenile whiting. Both adult and juvenile whiting expressed significant increases in HSP69 in response to temperature shocks of 24, 26, 28 and 30 ºC. Juvenile whiting had significantly higher basal levels of HSP69 than adult whiting and showed significantly more protein expression at 24 and 26 ºC. No mortalities were observed in juvenile fish at 30 ºC while 50% of adults suffered mortality at 30 ºC. Juveniles were exposed to temperature increase at 24, 26 and 28 ºC and HSP69 was measured after 24, 96 and 168 h. The HSP69 peaked at 96 h and by 168 h, exposure and returned to levels similar to 24 h post heat shock. Juvenile whiting elevated HSP induction at 96 h after heat shock. This study indicates juveniles have a better ability to cope with high temperature than adult and supports the fish behavioural pattern that younger fish inhabit near shore shallow water and then migrate to inshore deep water towards maturation.

The impact of salinity on KGW was assessed in an attempt to understand the mechanisms by which salinity could potentially influence habitat selection and growth of King George whiting in southern Australia. The experiment included whiting of two age classes, young of the year (YOY) and $2^+$ yr, at three salinities (30, 40, 50 ppt). YOY whiting showed no significant difference in length or weight gain, specific growth rate, feed intake, food conversion ratio or condition factor when exposed to the three salinities for 72 d. Plasma osmolality of YOY whiting was not significantly different at any salinity, though it was significantly lower than that of $2^+$ yr whiting. The $2^+$ yr whiting showed significantly higher plasma osmolality than the YOY. Blood plasma potassium and chloride levels of $2^+$ yr fish at 50 ppt were significantly higher than those at 30 ppt and 40 ppt. Blood sodium levels at 50 ppt

were significantly higher than at 30 ppt but the sodium level at 40 ppt was not different from 30 ppt or 50 ppt. Haematocrit of $2^+$ whiting was significantly higher at 30 than at 50 ppt while haematocrit at 40 ppt was not different from 30 or 50 ppt. The $2^+$ yr old whiting had a more pronounced increase in plasma osmolality and plasma ions at high salinities, indicating poorer osmoregulatory capacity in older fish. This study provides physiological evidence to partially explain habitat occupancy and growth in relation to salinity of different age groups of whiting in southern Australia.

Light is an important environmental factor regulating physiological process and ecological activities in fishes. This research aimed to examine the effect of light on the growth, distribution and body colour of juvenile KGW when exposed to different light levels under laboratory conditions. In this study, the fish were exposed to three light levels (25, 500, and 1000 lux) in triplicate for two months. Comparisons were made for growth, body colour and behavioural changes between treatments. During the experimental period, there were no statistical differences in specific growth rate, survival, growth efficiency and condition factor between the light levels. Although light did not affect swimming speed or the encounter rates, it did influence group flight activity and fish distribution in the tanks. Whiting in low light preferred to spend more time grouped at the bottom of the tank than at medium (500 lux) or high light (1000 lux). Likewise, after having been exposed to low light, whiting exhibited a brighter colour and had fewer body markings and counter-shading than fish in medium and high light intensities. The differences in fish distribution and body colour between medium and high light intensities were not detected. This study offers a new insight into understanding the impact of light on

behaviour and body colour of fish, which may contribute to the spatial distribution, predator avoidance and recruitment of fish in inshore coastal waters.

Adult fish stocks are highly dependent on the recruitment success of juveniles in the nursery grounds. A nursery site for post larval KGW was sampled to assess the potential for food competition with other species at King's Beach in the Barker Inlet, South Australia. All fish species were collected using seine nets with a 1-mm mesh along with concurrent sampling of both pelagic and benthic food resources. Post larval whiting <60 mm consumed primarily harpacticopid copepods and had high (>0.6) diet overlap with Gobidae and Syngnathidae families. Electivity index of fish species indicates that whiting post larvae preferred harpacticoid copepods and amphipods and Clinidae and Scorpaenidae fishes targeted larger prey items such amphipods. The difference in food preference between whiting and Clinidae and Scorpaenidae species was due to mouth morphology. Whiting showed an ontogenetic shift in diet with fish larger than 60 mm consuming less copepods and more amphipods and whiting larger than 120 mm consuming polycheate worms. Competition for food resources between whiting and other fish species in the Barker Inlet nursery ground is likely compromised through differences in temporal and spatial feeding behaviours, mouth morphology, and ontogenetic shift in prey consumption. However, habitat destruction caused by climate change and anthropogenic factors will increase competition for food resources by reducing spatial separation and food availability.

## STATEMENT OF DECLARATION

I certify that this thesis is a presentation of my original research work and that it does not contain without acknowledgement, any material previously submitted for a degree or diploma in any university. To the best of my knowledge and belief, it does not contain any material previously published or written by another person except where due reference is made in the text.

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Craig Meakin

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Craig Meakin

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