TRANS-TASMAN SEA LARVAL TRANSPORT: IS AUSTRLIA A SOURCE FOR NEW ZEALAND ROCK LOBSTERS?

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1 INTRODUCTION

Two species of rock lobster are commonly found in coastal waters around both New Zealand and Australia. Both species have relatively long-lived larval (known as phyllosoma). The most abundant species, *Jasus edwardsii*, has a larval life estimated to be between 12 and 24 months (Booth and Phillips, 1994). The duration of the phyllosoma stage in the less common species, *Sagmariasus verreauxi,* is not so well estimated but is thought to be between 8 and 12 months (Booth, 1986).

These long larval lifetimes raise the question of how populations can be maintained in regions where the mean flow advects larvae away from the coast. It has been suggested that Australia acts as a source of *Jasus edwardsii* larvae, and that phyllosomas drift across the Tasman Sea before metamorphosing near the west coast of New Zealand (Booth and Ovenden, 2000: Booth et al., 1990).

Both species exist in Australia, with *Jasus edwardsii* being found predominantly to the south, and *Sagmariasus verreauxi* being found to the north.

Previous work shows that *Jasus edwardsii* is genetically indistinguishable between Australia and New Zealand, whereas *Sagmariasus verreauxi* may be genetically different between the two countries.

Satellite altimeter data are used here to test the hypothesis that Australia acts as a source of larvae for some New Zealand populations of *Jasus edwardsii*, and to investigate if there is a physical mechanism for the seeming lack of gene flow for *Sagmariasus verreauxi.*

2 METHODS

A Lagrangian approach is used in which the western Tasman Sea is seeded with numerical drifters to build up a statistical summary of the likely distribution of larval trajectories.

Surface zonal and meridional currents were computed from the time varying dynamic height fields assuming geostrophy:

$$u = -\frac{10}{f}\frac{\partial}{\partial y}\Delta D_{0/2000} \qquad v = \frac{10}{f}\frac{\partial}{\partial x}\Delta D_{0/2000}$$

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where $\Delta D_{0/2000}$ is the time-varying dynamic height provided by AVISO/Altimetry, Space Oceanography Division France. Mean dynamic height is derived from the CARS climatology

3 RESULTS

Simulated trajectories and histograms of transit times from the runs made with the time-varying flow are shown in Fig. 1. The results show simulations made both with and without the effects of adding the Ekman wind-driven transport.

Statistics are summarized by the median transit time, and two percentile numbers. The first percentile number is the percentage of all releases that arrive in New Zealand. The second percentile is the percent of all transit times that fall within one larval life time for the species under consideration.

3.1 Jasus edwardsii

The *Jasus edwardsii* source region is presumed to be near Bass St. The median transit time is 1099 days for the runs with no winds. About 64% of releases from Bass St arrive in New Zealand waters, and about 14% of released phyllosomas arrive in New Zealand in less than 2 years.

Prevailing winds in the south Tasman Sea are from the west or south west. These winds have an Ekman component directed to the north or north-west so that the main effect of adding the winds to the simulations is to shift the latitudinal spread of the tracks north, especially to the south of 45°S, and to increase the median transit time to 1115 days. The number of arrivals reduces because more drifters pass north of New Zealand (not shown). About 37% of releases arrive in New Zealand waters, and about 8% of released larvae arrive in less than 2 years.

3.2 Sagmariasus verreauxi

The *Sagmariasus verreauxi* source region is presumed to be between 34° and 30°S. Without winds, about 28% of trajectories reach New Zealand waters. Most arrivals are in the north of the North Island, but some are as far south as Fiordland. The median transit time is 838 days, and 3% of released drifters take less than one year to cross the Tasman Sea. When the winds are added, the median transit time decreases to 759 days, and 2% of larvae take less than one year to cross the sea.

Trajectories where transit times were less than one year show that only those drifters that get entrained in the Tasman Front cross the sea within one larval lifetime.

4 DISCUSSION

Ignoring biological factors, about 8% of *Jasus edwardsii*, and about 2% of *Sagmariasus verreauxi* larvae might be expected to arrive in New Zealand waters within their respective larval lifetimes.

One can calculate minimum biological survival rates that would allow populations to survive given these probabilities by noting that on average only 2 phyllosomas from each female are required to survive into adulthood and reproduce. It is safe to assume that on average each *Jasus edwardsii* female hatches at least 2 000 000 phyllosomas over her life time. Thus the populations of *Jasus edwardsii* would be maintained provided the biological survival were 0.0013% or higher.

Estimates of mortality are notoriously problematic and variable, but based on existing estimates, we believe that survival rates in reality are about 0.03%, i.e. 24 times higher than the minimum required 0.0013%.

The factor 24 is comfortably large, so that we suggest that for virgin fish stocks, the probability of larvae crossing the Tasman Sea during one lifetime is high enough that West Coast New Zealand populations could be maintained from Australia.

A lot less larval transport is required to maintain genetic homogeneity than is required to maintain the entire population. If a trans-Tasman survival rate of 8% suffices to maintain *Jasus edwardsii* populations, it is difficult to imagine that a survival rate of 2% does not maintain genetic homogeneity for *Sagmariasus verreauxi*.

Based on these simulations, it appears that larval flow across the Tasman Sea should be sufficient to at least maintain trans-Tasman genetic homogeneity in both species. But if *Sagmariasus verreauxi* is isolated across the Tasman Sea as suggested by the genetic data, then this implies that there is a biological mechanism blocking gene transfer.

One such reason may be that for *Sagmariasus verreauxi* phyllosomas to cross the Tasman Sea within one year, they would have to cross north of the productive Subtropical Front (STF), and it may be that there is just not enough prey to sustain them.

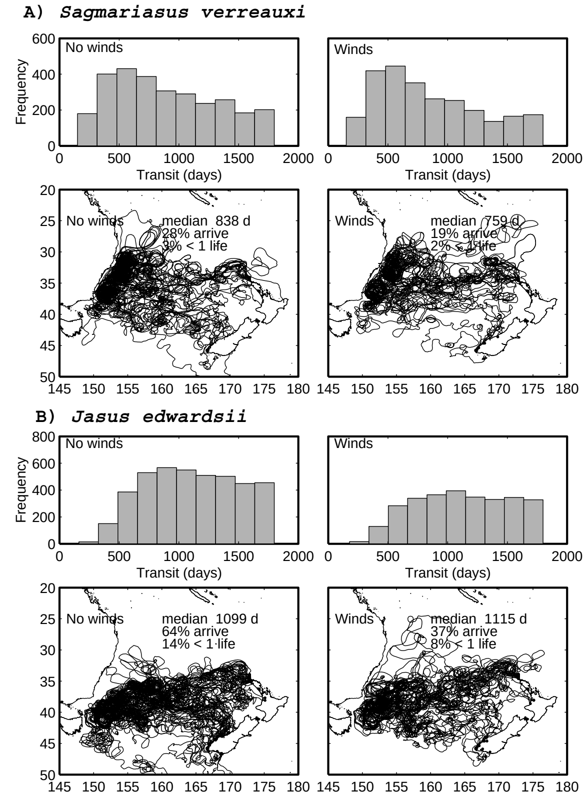

Fig. 1. Histograms of trans-Tasman transit times and selected tracks for numerical simulations. A) for *Sagmariasus verreauxi*. Left hand panels show results for runs made without winds, right hand panels show results for runs made including winds (see text). Only those tracks that arrive in New Zealand are shown. For these runs, one larval lifetime is taken to be 1 year. B) as in A, but for *Jasus edwardsii*. For these runs, one larval lifetime is taken to be 2 years.

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