Defining movement characteristics of Victoria’s Giant spider crab

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Green, C., Klemke, J., Jalali, A.

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Contact Details:
Victorian Fisheries Authority
1 Spring Street Melbourne VIC 3001

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Summary

In Port Phillip Bay during the cooler winter months, Giant spider crabs (*Leptomithrax gaimardii)* aggregate in large numbers thought to be associated with moulting and reproduction. Aggregations occur at multiple locations in the bay, including a regular aggregation close to Rye or Blairgowrie pier. This is the only well-known crab aggregation that is regularly accessible to both pier-based recreational divers, fishers and public. There is high public interest in this species from stakeholder groups, highlighting the importance of careful and informed future management of the fishery. The Victorian Fisheries Authority (VFA) is responsible for the management of fishing for Giant spider crab and providing for diverse fishing opportunities for future generations to enjoy. The VFA adopts a balanced management approach to the Giant spider crab fishery, incorporating science and providing for diverse community values. The daily catch and possession limit for spider crabs, including giant spider crabs, was recently halved from 30 to 15 to better balance spider crab values and more equitably share spider crabs between fishers and other stakeholders. The Victorian Fisheries Authority believes that the Giant spider crab stock is essentially at virgin biomass levels given the low recreational catch and the spatially and temporally discrete fishing location/periods.

Determining movement characteristics and stock structure of a fishery is important as it defines a species distribution, individual stock boundaries, connectivity from one region to another, and is vital for fisheries management purposes. Gaining a greater understanding of stock structure and connectivity of a species allows fisheries managers to objectively determine if a species should be managed as a single, or multiple entities. For example: Giant spider crabs have a wide distribution across south east Australian marine waters, being common in shallow waters but found to more than 800m depth[1]. If a stock of Giant spider crabs within Port Philip Bay solely functions as a separate entity compared to crabs caught at other locations within their natural distribution, should they be managed separately?

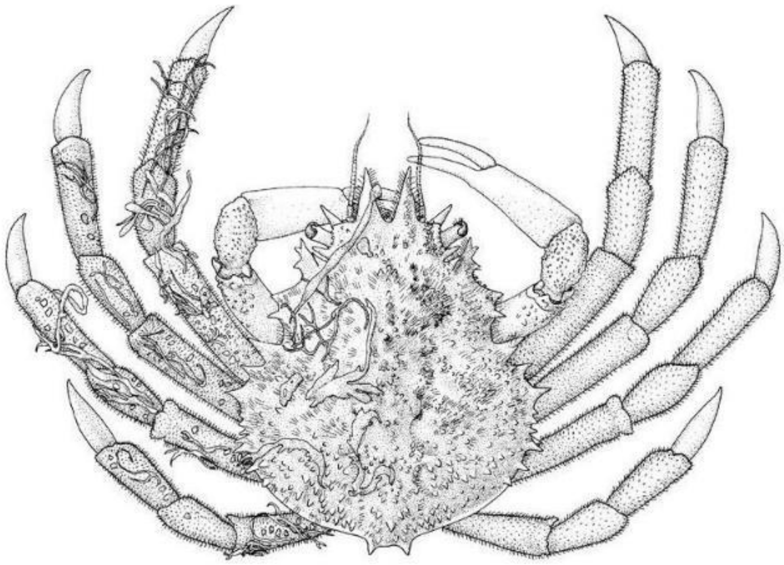
In an Australian first during late July 2020, 15 Giant spider crabs collected near Blairgowrie in southern Port Phillip Bay, Victoria, Australia, were fitted with satellite tracking devices and released in their natural environment to gain a greater understanding of their movement characteristics post-aggregation. Data supported the hypothesis that crabs disperse post-aggregation where they are likely to remain independent before aggregating again. Location data was successfully obtained from 12 crabs. Independent of the time at liberty, all 12 crabs were found in <15 metres of water. No animals were found to have moved to deeper parts of Port Phillip Bay during their maximum time at liberty (77 days) which was previously thought to have occurred. Although most animals were found within 7 km of their deployment location, two Giant spider crabs were observed to travel much further distances. One crab travelled approximately 12 km in 77 days where it was found to reside off Swan Island; whereas, another crab travelled approximately 42 km in 55 days where it was located outside Port Phillip Bay near Cape Shank. While there appears to be a misunderstanding by some stakeholders that giant spider crab only aggregate in southern Port Phillip Bay off Rye and Blairgowrie; this project validates that crabs have the ability to move in other regions of Port Phillip and not restricted in moving within Port Phillip Bay's boundaries. Aggregations have been observed off Queenscliff, Swan Bay and St. Leonards.

Such movement activity supports the hypothesis that giant spider crabs have the capacity to move large distances, are capable of stock replenishment via immigration and emigration and not solely restricted to southern Port Phillip Bay. Giant spider crabs are found along the coast of Victoria and beyond, as such connectivity of crab stocks within PPB with crab stocks offshore cannot be dismissed.

[1] Atlas of Living Australia https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:50b6d98f-cf91-4af3-b95a-565d8acd6b94#

Introduction

The giant spider crab *Leptomithrax gaimardii* (H. Milne Edwards, 1834) is Victoria's largest spider crab and can reach 16 cm across their carapace or shell, and 70 cm across their legs (Taylor, 2011). They can be identified by their orange colour and very long legs in comparison to the size of the carapace (Edgar, 2000); and can have seaweed, sponges or sea squirts attached to their exoskeleton. Distributed predominantly along the south eastern coast of Australia (Atlas of Living Australia) they inhabit depths of up to 800 m although seasonally abundant in shallow inshore embayment's and estuaries during winter (Gardner 1999; Turner 2001; https://collections.museumvictoria.com.au/species/14370). Giant spider crabs are scavengers, eating a range of different types of food on or near the seafloor and have been observed inflicting non-lethal impacts on the northern Pacific seastar (*Asteria amurensis*) (Ling et al 2013). Research of the abundance of fish and invertebrates conducted in Port Phillip Bay from 1990 to 2002 indicated the presence of giant spider crab between 7 and 17 metres (Parry et. al. 2003).



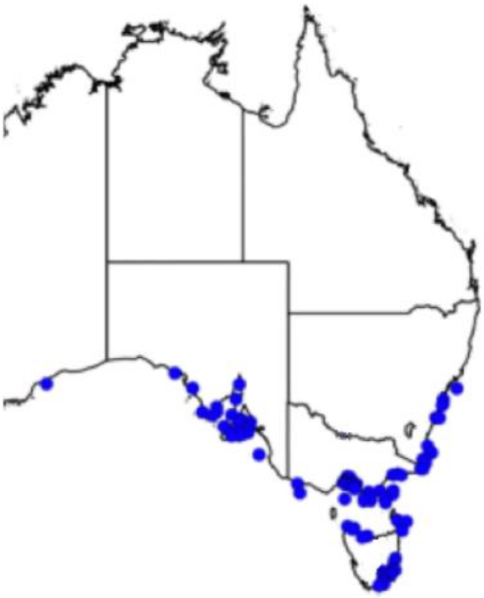


Figure 1. A dorsal view illustration of a Giant Spider Crab (Left; Museum Victoria); and the distribution of Giant spider crab *Leptomithrax gaimardii* in Australia (Right; Atlas of Living Australia).

During the cooler months from late May to July, Giant spider crabs are thought to move from deeper waters of Victoria's Port Phillip Bay and coastal waters into shallow water <5m deep as a part of an annual migration/aggregation cycle. Such aggregations (Figure 2) have been noted to occur in waters of southern Port Phillip Bay (e.g. Rye, Blairgowrie, St Leonards, Queenscliff) particularly around the full moon, and in protective waters of eastern Victoria's Gippsland Lakes system. However, there are also anecdotal reports by divers of giant spider crab aggregations at a range of other locations around Port Phillip Bay and other Victorian coastal waters. Aggregations are not only restricted to Victoria but also occur in adjoining states of South Australia and Tasmania (Gardener, 1999). Aggregations are often visible from the water's surface as their aggregative form is distinguishable compared to other sand/reef or algae habitats.

Figure 2. Giant spider crab aggregation in southern Port Phillip Bay (Image credit: Brett Illingworth).

Spider crabs are a highly prized seafood and commercially harvested around the world. Commercial fishing for the giant spider crabs in Port Phillip Bay is restricted due to recent changes to Port Phillip Bay Fishery Access Licences and the removal of scallop dredging more than two decades ago. In April 2022, all commercial netting will cease in Port Phillip Bay. The recreational fishery is managed by the Victorian Fisheries Authority using a catch limit of 15 crabs and compliance with regulations is generally high. Giant spider crabs are taken as a bycatch in other State and Commonwealth fisheries in South East Australia. The Victorian Fisheries Authority believes that the giant spider crab stock is essentially at virgin biomass levels given the low recreational catch and the spatially and temporally discrete fishing locations/periods.

Determining movement characteristics and stock structure of a species is important as it defines distribution boundaries, connectivity from one region to another and is required for fisheries management purposes. The stock structure for Giant spider crab has yet to be defined in south eastern Australia. However, they have been reported to be found off the coast of South Australia (Michael Steer; South Australian Research and Development Corporation), D'Entrecasteaux Tasmania (Sean Tracey; Institute for Marine and Antarctic Studies) and off the southern coast of New South Wales (John Stewart; NSW Fisheries) (Figure 1). Broad distribution of Giant spider crabs along coastal regions of south eastern Australia infers a level of connectivity possibility attributed to larval dispersion or movement along the ocean floor. Movement characteristics of Giant spider crabs has yet to be researched and is an important factor when considering population connectivity. Such information provides an insight of the spatial connectivity of crabs within and possibly outside Port Philip Bay where aggregations occur. As such, understanding movement characteristics will be focused on Giant spider crabs found in southern Port Phillip Bay post-aggregation and will be used to address a knowledge gap of this species.

This study aims to

- Use satellite tags to explore movement characteristics of Giant spider crabs tagged in southern Port Phillip Bay.

This research will also compliment a future genetic population connectivity study. During 2021, the VFA is collaborating with Deakin University to determine stock structure of Giant spider crabs in south eastern Australia including analysing the connectivity of Giant spider crabs within Port Phillip Bay compared with those found along Victoria’s coastline adjacent to Bass Strait.

Methods

Tagging techniques used on crustaceans are well established, for example wired label tags have been used to study movement and growth characteristics of blue swimmer crabs in Western Australia (WA research angler program No 29); and acoustic telemetry has been used to track snow crab *Chionoecetes opilio* movements off Nova Scotia, Canada (Cote *et.al.* , 2019). Only one study has been found using satellite technology to track movement of crabs. Davidson and Hussey (2019) successfully tagged and monitored movement patterns of the porcupine crab (*Neolithodes grimaldii*) in Northern Davis Strait, Eastern Canadian Arctic.

Annual aggregations of Giant spider crab occur in various locations in Port Phillip Bay and beyond. However, a well-known aggregation has been regularly occurring in recent years near Blairgowrie and Rye piers (Victoria) that is visible and accessible to public off piers and targeted by recreational fishers. As such, movement characteristics were studied within these locations.

On 30th July 2020 (post crab aggregation), 15 Giant spider crabs were collected by divers, fitted with Mark Report Pop-up Archival Tags (mrPAT; Wildlife Computers Ltd) and released at the approximate location of capture.

Research vessels positioned scientific divers at locations of southern Port Phillip Bay approximately 1 km offshore from Blairgowrie (Victoria). At approximately 10 metres depth, a giant spider crab was collected by hand by holding on to the carapace (external shell) and transferring it to a submerged 20L bucket. A lid was placed onto the bucket and brought to the research vessel. The crab was transferred to a shallower seawater filled wide bucket (similar to a ‘fish bin’ – 80x40cm) onboard the vessel. Biological information such as carapace length, width and sex were recorded from each Giant spider crab. Methods used to attach mrPAT’s to Giant spider crabs were like those described by Davidson (2019). Tags were secured using a harness method whereby a 2 mm fluorocarbon line was positioned around the crab’s carapace between the third and fourth legs and secured with 3 mm crimps (Figure 3). The satellite tag leader line, approximately 10cm in length, was secured to the crab harness and crimped. To reduce the impact of the tag buoyancy on the natural behaviour of the crab, a small lead weight (10g) was fitted to the leader line which meant the tag was only slightly positively buoyant. Each individual crab was transferred back to the 20L bucket, lid replaced, and taken to the ocean floor where it was released. During the entire tagging procedure impact such as stress to the animal was minimal.

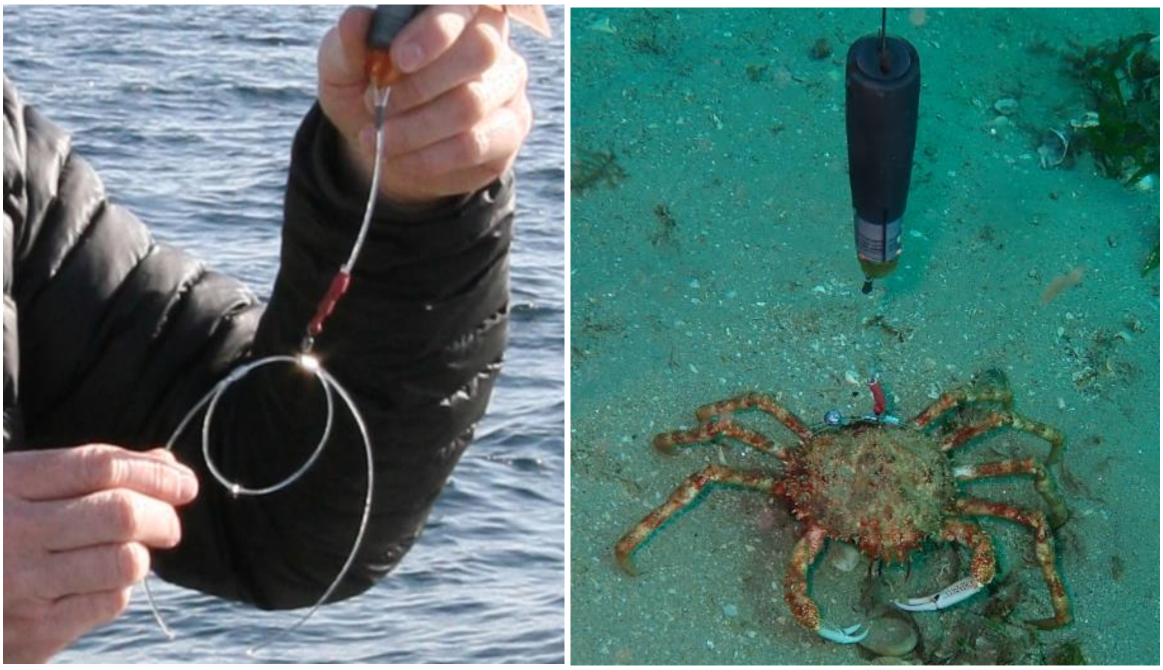


Figure 3. Monofilament harness prepared to be fitted on to a Giant spider crab (left); Giant spider crab fitted with the harness and mrPAT satellite tag (right).

One tag assigned to each Giant spider crab was programmed using TagAgent (Wildlife Computers) to be automatically released on a weekly basis (7 days) from 30 July 2020. This enabled short, medium, and long-term movement capability to assessed. As such, the most amount of time a spider crab will have a tag attached will be approximately four months. Four months at liberty will give an indication of where crabs are during the cooler and warmer water temperatures seasons. When tags are released from the harness they float to the surface where they connect to the Argos satellite network once the dry sensor has been activated. Tags were programmed to transmit continuously every 90 second for the duration of the battery life (Hussey et al., 2018).

Project success was determined by successfully tagging and gaining movement information. Any movement characteristics obtained from the tags will be considered a success (whether they have moved or not). The harness will remain on the crab until the next moult which is anecdotally thought to occur on an annual basis. Crabs moult by exiting their own exoskeleton from the rear of the animal. Consequently, the harness will remain on the old exoskeleton after moulting and is highly unlikely to impede the moulting process.

Data obtained from the mrPATs included the date and time each tag was water activated, date and time the tag was released activated for release, whether the tag was released prematurely due to mortality or shedding/moulting, location and accuracy of the location determined, the time which the tag first surfaced until the location was determined. Time at liberty was transformed to decimal days and the average speed (m per day) was calculated. Speed was estimated based on the Giant spider crab travelling a direct line).

Unlike GPS quality locations with a known accuracy (typically 10's m at worst), Argos locations are a far more complex to derive, using complex filtering algorithms from infrequent short data messages from the tag. At best, the algorithms produce a lat/long with a stated accuracy (radius of error) of < 250 m in ideal situations (frequent surfacing, close intervals and good weather) to > 1,500 m if the uplinks are sparse and weather conditions not ideal. Such error classification is reported for each tag.

Tagging Giant spider crabs was granted animal ethics approval by the Deakin University Animal Ethics Committee (B21-2020 – Understanding movement characteristics of giant spider crabs in Port Phillip Bay).

Results

A total of 15 Giant spider crabs (7 male, 8 female) were successfully tagged on 30 July 2020, approximately 1.2 km north east from the Blairgowrie foreshore (Figure 4).. Size of crabs ranged from 90 – 124 mm carapace length. Upon release, crabs appeared active and very capable of moving along the ocean floor without being impeded by the harness or a slightly positively buoyant tag attached. Crabs successfully recorded movement data from 1 – 77 days at liberty. Seven of the 15 tagged crabs released their tags at the programmed schedule date (Table 1). Four tags where classified as 'floaters' indicating that tags prematurely detached from the crab due to factors such as, death, harness detachment or the shedding the tag harness during moulting. Despite premature tag release, such data is still valuable in determining movement. Data was not available for three tagged crabs possibly due to tags being released but caught in algae, under reefs or other structures.

The time between satellite tags reaching the ocean surface and the time in which the tags connected to satellites to acquire a latitude and longitude location varied from 22 minutes to 18 hours (Table 1). As such the location of the tag can only be assumed to be an approximate location of the crab given the tag can drift in association with variable oceanographic conditions (tide, wind etc).

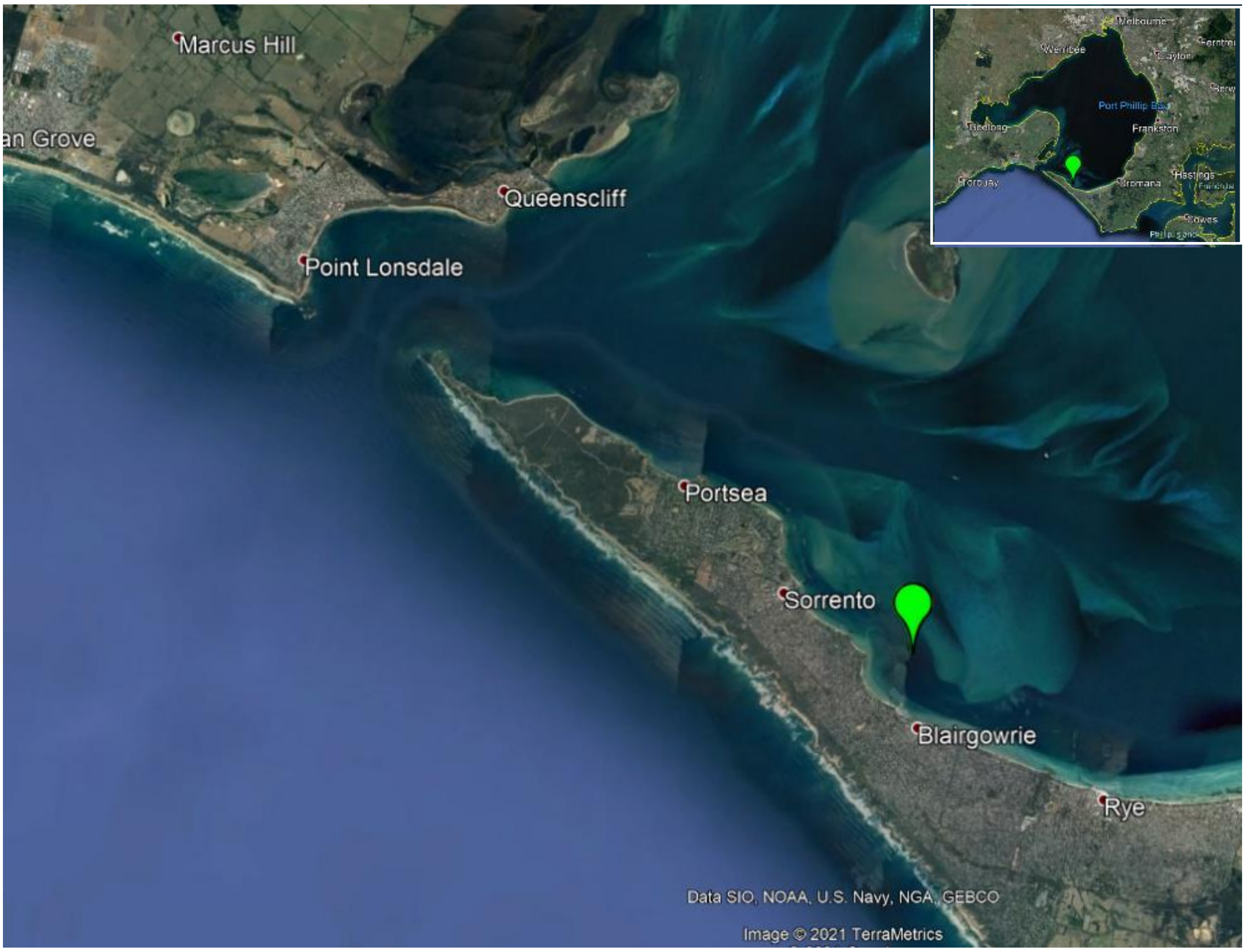


Figure 4. General location where 15 Giant spider crabs were collected, fitted with satellite tags and released on 30 July 2020 (Green location mark). Insert illustrates location of the tagging site relative to Port Phillip Bay, Victoria, Australia.

Table 1. Summary of giant spider crabs tagged on 30 July 2020. Satellite tag details include the number mrPAT release dates that were programmed.

Tag ID	Crab size (carapace length, mm)	Sex	Release programmed (days)	Expected release date	Actual release date	Deployment length (days)	Number of days tag was prematurely released	Release reason	Time Release initiated (UTC)	Time tag reached surface (UTC)	Time from pin burn to surfacing (hh:mm:ss)	First location (UTC)	Time from surfacing to first location (hh:mm:ss)
31	90	Male	7	6-Aug-2020	6-Aug-2020	7	0	Scheduled	2:06:00	10:23:00	8:17:00	10:45:59	0:22:59
32	93	Male	14	13-Aug-2020	13-Aug-2020	14	0	Scheduled	2:24:00	10:26:00	8:02:00	11:16:26	0:50:26
33	114	Female	21	20-Aug-2020	20-Aug-2020	21	0	Scheduled	2:33:00	11:32:00	8:59:00	19:34:38	8:02:38
34	104	Male	28	27-Aug-2020	27-Aug-2020	28	0	Scheduled	2:36:00	11:44:00	9:08:00	12:11:12	0:27:12
35	109	Female	35	3-Sep-2020	31-Jul-2020	1	34	Floater	4:00:00	4:00:00	0:00:00	7:01:01	3:01:01
36	103	Female	42	10-Sep-2020	10-Sep-2020	42	0	Scheduled	2:58:00	14:58:00	12:00:00	20:53:18	5:55:18
37	102	Female	49	17-Sep-2020	20-Sep-2020	NA		Unknown	NA	NA	NA	NA	NA
38	90	Male	56	24-Sep-2020	24-Sep-2020	56	0	Scheduled	3:05:00	13:08:00	10:03:00	21:41:22	8:33:22
39	102	Female	63	1-Oct-2020	19-Oct-2020	18	45	Scheduled	3:10:00	1:35:00	22:25:00	7:26:54	5:51:54
40	100	Female	70	8-Oct-2020	21-Sep-2020	53	17	Floater	1:00:00	1:00:00	0:00:00	8:42:50	7:42:50
41	95	Male	77	15-Oct-2020	15-Oct-2020	77	0	Scheduled	3:29:00	12:30:00	9:01:00	7:19:31	18:49:31
42	105	Female	84	22-Oct-2020	23-Oct-2020	NA	NA	NA	NA	NA	NA	NA	NA
43	95	Male	91	29-Oct-2020	NA	NA	NA	NA	NA	NA	NA	NA	NA
44	101	Female	98	5-Nov-2020	23-Sep-2020	55	43	Floater	2:00:00	2:00:00	0:00:00	10:47:23	8:47:23
45	124	Male	105	12-Nov-2020	9-Sep-2020	41	64	Floater	3:00:00	3:00:00	0:00:00	6:37:15	3:37:15

Giant spider crabs were observed to have moved within various regions of southern Port Phillip Bay (Figure 5). There was no clear correlation between days at liberty and distance $F_{(1,9)}$ =1.13, p=0.314 (Table 2). Most crabs were with 2 km of the foreshore; however, at least three crabs would have experienced depths of approximately 20 m whilst at liberty. Greatest distance travelled included one moving 12 km towards Queenscliff (Figure 5; Appendix 1; Tag ID No. 41) and another moving approximately 42 km reaching a coastal location off Cape Shank (Figure 5; Appendix 1, Tag ID No. 44). Water temperature experienced by giant spider crabs ranged from 10ºC to 15ºC (Figure 6). Giant spider crab tag numbers 38, 39 and 44 displayed in an increase water temperature with time.

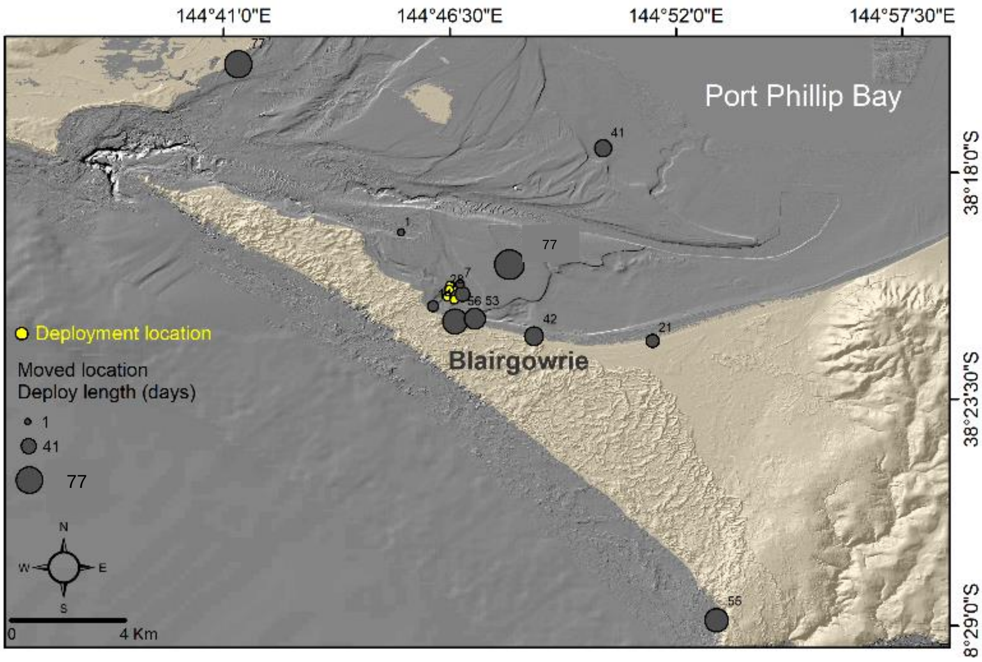


Figure 5. Deployment location (yellow circle) and approximate position giant spider crab location (grey circles) in southern Port Phillip Bay. Size of the grey circle reflects the relative duration each crab was at liberty; numbers accompanying each location represents days at liberty.

Table 2. Deployment location, moved location, distance covered and speed of Giant spider crabs from southern Port Phillip Bay. * denotes potential error with location moved see discussion for description.

Tag ID	Crab size (carapace length, mm)	Sex	Deployment length (Decimal days)	Deployment Location (Lat and Long)	Moved location (Lat and Long)	Distance between deployed location and moved located (km)	Average Speed km/decimal day	Error classification	ARGOS Satellite location accuracy
31	90	Male	7.09	-38 21.073 144 46.593	-38.345 144.779	0.72	0.10	1	500 - 1500 m
32	93	Male	14.10	-38 21.006 144 46.435	-38.354 144.768	0.68	0.05	2	250 - 500 m
33	114	Female	21.11	-38 21.001 144 46.435	-38.368 144.857	7.54	0.36	3	<250 m
34	104	Male	28.11	-38 20.994 144 46.436	-38.349 144.780	0.54	0.02	B	No error value
35	109	Female	1.17	-38 20.826 144 46.471	-38.324 144.755	3.08	2.64*	1	500 - 1500 m
36	103	Female	42.12	-38 20.826 144 46.471	-38.366 144.809	3.68	0.09	3	<250 m
37	102	Female	NA	-38 20.826 144 46.471	NA	NA	NA	NA	NA
38	90	Male	56.13	-38 20.826 144 46.471	-38.360 144.777	1.45	0.03	3	<250 m
39	102	Female	63.13	-38 20.738 144 46.498	-38.337 144.799	2.31	0.04	2	250 - 500 m
40	100	Female	53.04	-38 20.729 144 46.501	-38.359 144.785	1.74	0.03	2	250 - 500 m
41	95	Male	77.15	-38 20.729 144 46.501	-38.256 144.689	12.47	0.16	3	<250 m
42	105	Female	NA	-38 20.729 144 46.501	NA	NA	NA	NA	NA
43	95	Male	NA	-38 20.729 144 46.501	NA	NA	NA	NA	NA
44	101	Female	55.08	-38 20.761 144 46.558	-38.481 144.883	42.00	0.76	3	<250 m
45	124	Male	41.13	-38 20.814 144 46.472	-38.290 144.837	8.36	0.20	2	250 - 500 m

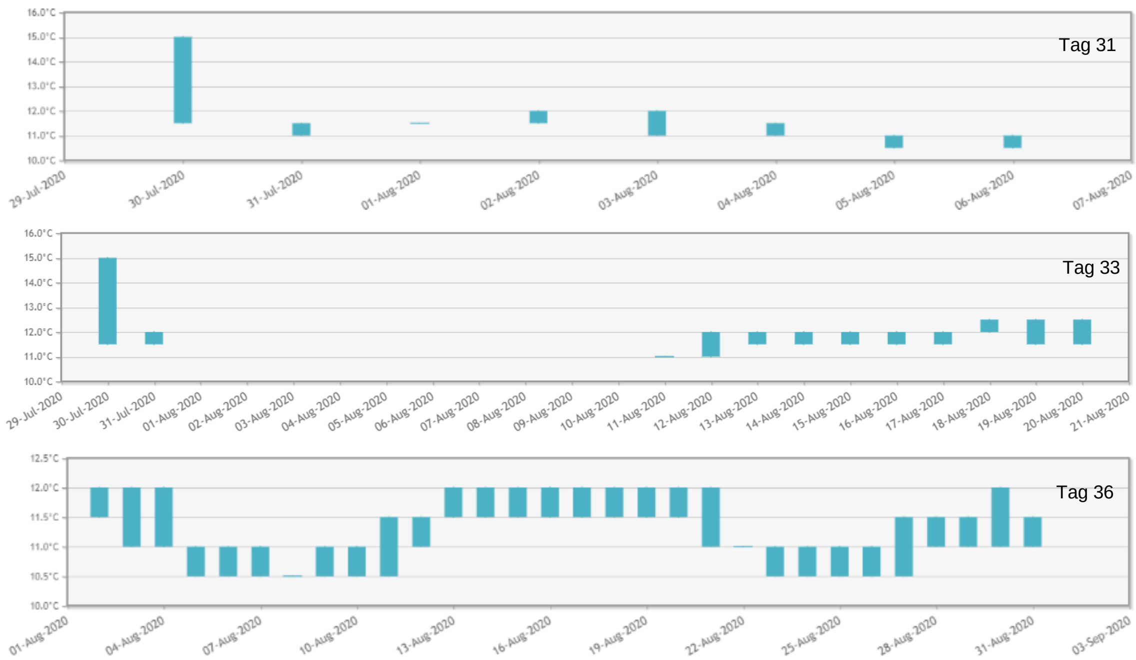


Figure 6. Minimum and maximum water temperature data collected from satellite tags. Temperature data is only provided where temperature was obtained. Note that maximum temperature displayed for 29th / 30th July 2020 represents ambient air temperature.

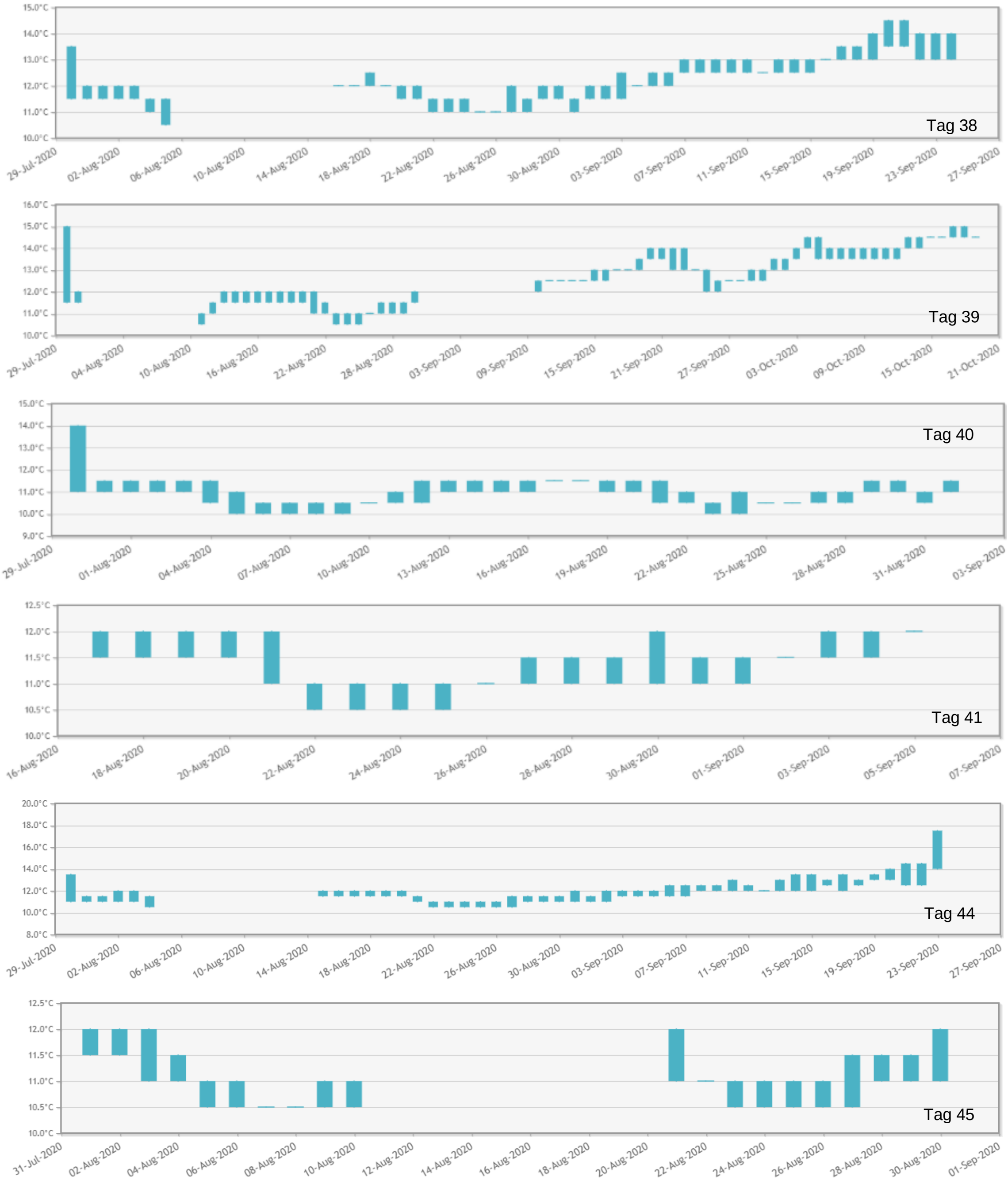


Figure 7 (Continued). Minimum and maximum water temperature data collected from satellite tags. Temperature data is only provided where temperature was obtained. Note that maximum temperature displayed for 29th / 30th July 2020 represents ambient air temperature.

Discussion

Gaining a greater understanding of a species population dynamics is important when considering alternative management regimes. Movement characteristics of individuals can provide an insight of the connectivity a species has within its distribution and its accessibility to important habitats for feeding, reproduction, or protection. Historically, tagging crustaceans has been used extensively throughout world to delineate temporal and spatial movement patterns (DeWolfe, 1974). Technological advances such as acoustic telemetry has greatly enhanced knowledge of movement characteristics of several crustaceans including snow crab (*Chionoecetes opilio*) (Cote et al., 2019; Nichol et al., 2017), American horseshoe crab (*Limulus polyphemus*) (Martinez et al., 2018), Atlantic rock crab (*Cancer irroratus*) (Comeau et al., 2012), and scampi (*Metanephrops challenger*) (Tuck et al., 2015). Acoustic tagging technologies are very useful when investigating movement characteristics where likely movement patterns are understood, and an acoustic receiver array adequate to capture movement can be deployed to capture observations. However, capturing spatial and temporal movement activity using satellite technology can provide a baseline of movement characteristics where an acoustic array may not be sufficient in capturing larger movement and may be less beneficial in such circumstances. As such, new information and techniques can be applied to gain further insight on movement, habitat utilization and distribution.

In an Australian first, 15 Giant spider crabs were successfully harnessed with satellite tags and movement characteristics obtained. Although three tags did not provide data for analysis, 12 animals provided valuable knowledge of their movement within and outside of Port Phillip Bay, Victoria, Australia. Data supported the hypothesis that these crabs disperse post-aggregation where they are likely to be solitary entities. Independent of the time at liberty, all crabs were found in <15 metres of water. No crabs were found to have moved to deeper parts of Port Phillip Bay which was previously thought to have occurred. The speed that giant spider crabs move (0.03 – 0.76 km/day) are within the speed range of other crabs including snow crabs (*Chionoecetes opilio*) (0.1–1.1 km per day, Nichol et al.,2017), and porcupine crabs (*Neolithodes grimaldii*) (Davidson and Hussey; 2019). However, Giant spider crab Tag ID35, recorded a speed of 2.64 km per day during the one day while it was at liberty. Given the relatively poor level of satellite accuracy (500 – 1500m) and the short period of time at liberty (~1 day), it is unlikely that its recorded location (and therefore speed) was reflective of its actual speed and was not used in further analyses.

Although most animals were found within 7km of their deployment location, two giant spider crabs were observed to travel much greater distances. Giant spider crab Tag ID No. 41 travelled 12.47 km in 77 days where it was found to reside off Swan Island whereas Giant spider crab Tag ID No. 44 travelled approximately 42 km in 55 days where it was located outside Port Phillip Bay near Cape Shank. There appears to be a misunderstanding by some stakeholders that giant spider crab only aggregate in southern Port Phillip Bay; however, this project validates that crabs have the ability to move in other regions of Port Phillip and capable of moving out of into Bass Strait. Since tagging, this Giant spider crab (Tag ID No.44) successfully moved to the mouth of Port Phillip Bay (‘The Rip’) where it would have experienced relatively high levels of water current, then travelled outside Port Phillip Heads where it moved south east along Victoria’s coastline. Accuracy of the tag/crab found at this location was within 250m. Such movement activity supports the hypothesis that giant spider crabs have the capacity to move large distances and not solely restricted to southern Port Phillip Bay. Giant spider crabs are found along the coast of Victoria and beyond, as such connectivity of crab populations within PPB with crabs offshore cannot be dismissed, albeit only one observation. Similarly, giant spider crab individuals and aggregations have been observed in other regions of Port Phillip Bay including St. Leonards and Queenscliff.

The accuracy of the tags position is reliant on two main factors, the Argos Satellite Location accuracy and the time the satellite spent on the surface while attempting to find a satellite to obtain a position. For most tags (five of the 15) accuracy was within 250 m while eight tags were classified as being accurate within 500m. The time it took for a tag to connect to satellites after surfacing ranged from 23 minutes to 18 hours. A number of factors influence the length of time it takes to connect to a satellite and acquire a position including the number of satellites within the connective orbit and sea surface conditions. For example, during rough oceanographic conditions tags may become swamped by waves causing connectivity issues. It is expected that the greater period of time which a tag is floating will reflect a greater distance between the location of the crab and the observed location of the floating tag. Incorporating drift speed and direction was not incorporated into this study as it was thought to be to dynamic to accurately describe.

Port Phillip Bay covers 1930 km^2 and has a diverse array of habitats and oceanographic systems. Tagged Giant spider crabs were subjected to various water temperatures (mostly within Port Phillip Bay). Temperatures recorded were similar to those expected to be found in adjacent waters such as Western Port Bay and even further east of the state (Corner Inlet and Gippsland Lakes system). As such oceanographic conditions with favourable habitat and food availability would likely support Giant spider crabs in Western Port Bay and other regions along Victoria and Bass Strait.

Such movement activity supports the hypothesis that giant spider crabs have the capacity to move large distances, are capable of stock replenishment via immigration and emigration and not solely restricted to southern Port Phillip Bay. Giant spider crabs are found along the coast of Victoria, as such connectivity of crab stocks within PPB with crab stocks offshore cannot be dismissed. Further research is planned to accompany movement characteristics to further delineate the stock structure in Port Phillip Bay and connectivity with giant spider crabs found in Victoria’s offshore environment and adjacent jurisdictions (South Australia, Tasmania, and New South Wales).

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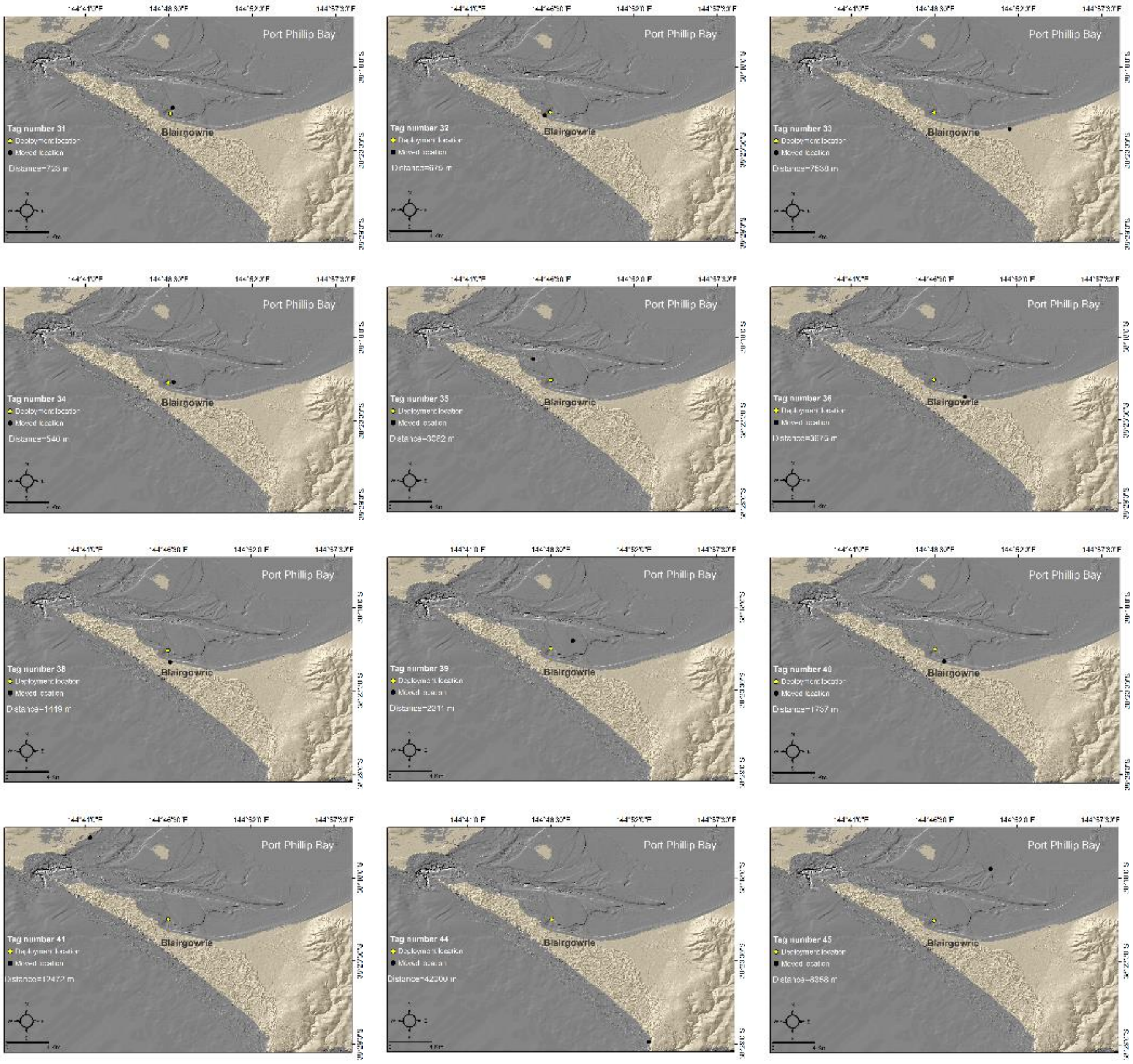
Appendix 1



Appendix 1. Movement location and distance travelled of Giant spider crabs in Port Phillip Bay.

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