Project Plan SP 2020-006

Ecology, threats and monitoring of the Pilbara Olive Python (*Liasis olivacea barroni*)

Animal Science

Project Core Team

Supervising Scientist	David Pearson
Data Custodian	David Pearson

Project status as of Nov. 11, 2021, 1:27 p.m.

Pending project plan approval

Document endorsements and approvals as of Nov. 11, 2021, 1:27 p.m.

Project Team	required
Program Leader	required
Directorate	required
Biometrician	required
Herbarium Curator	not required
Animal Ethics Committee	required

Ecology, threats and monitoring of the Pilbara Olive Python (*Liasis olivacea barroni*)

Biodiversity and Conservation Science Program

Animal Science

Departmental Service

Service 7: Research and Conservation Partnerships

Project Staff

Role	Person	Time allocation (FTE)
Supervising Scientist	David Pearson	0.6

Related Science Projects

No related projects.

Proposed period of the project

None – None

Relevance and Outcomes

Background

The Pilbara Olive Python (POP; *Liasis olivaceus barroni*) is an iconic threatened species confined to the Pilbara and adjacent northern part of the Gascoyne IBRA regions. Very little is known about its ecology, habitat preferences and conservation threats. It was described as a distinct taxon by Smith (1981) and recent genetic work has indicated its distinction from northern populations of the Olive Python (*L. o. olivaceus*) (Pearson and Spencer). Pearson (1993) reported on its distribution and conservation status based on the few available Museum specimens and records submitted by the public during a postal survey. Information on the python's diet, home range and basic biology based on limited telemetry data, observations and roadkill specimens was summarized in Pearson (2007).

The POP is an apex predator consuming a diet of large birds, reptiles and mammals as an adult, including several species such as Northern Quolls and Rothschild's Rock-wallabies that are either threatened or have declined in abundance. The diet of neonate and juvenile pythons is unknown but may consist of frogs, small birds and lizards. POPs occur in a range of habitats, including ironstone, dolerite and granitic hills and their watercourses. They are primarily nocturnal, but may be encountered in the cooler winter months basking near shelter. Mating also occurs at this time. Females are 'capital-breeders' and need to have sufficient body resources to develop and incubate eggs. It takes considerable time post-reproduction to recover lost condition, so it is probable that females skip one or more years before breeding again (Pearson 2007). POPs occur in several national parks and conservation reserves managed by the DBCA. It is WA's largest snake and a species of interest and novelty to the wider public and Pilbara residents in particular. It is a listed "Vulnerable" species under the EPBC Act and "Threatened" under WA legislation.

The threats faced by POPs are not well understood. Pearson (2007) listed the loss of important prey items such as rock-wallabies and quolls due to predators, habitat loss and modification due to open cut mining activities, infrastructure development; and on a local scale, increases in vehicular traffic due to resources projects and tourism with resultant increases in roadkills. The loss of vegetation cover (shelter and ambush sites) due to grazing and trampling by stock in riparian areas may be significant factors for juvenile pythons and wildfire may remove vegetation cover over large areas and reduce prey resources.

There is need for better life history and biological information on the diet, habitat preferences for adults and juveniles, predators, reproductive frequency, and the location of important landscape features for nesting and mating to aid conservation planning and to establish appropriate monitoring protocols. This information is also required to develop sensitive monitoring techniques to assess the effectiveness of management actions as well as mining and infrastructure impacts. Radio-telemetry of POPs remains the most effective technique to collect such data (Tutt, Mitchell, Brace and Pearson 2002; Tutt, Fekete, Mitchell, Brace and Pearson 2004). Pythons can be fitted with transmitters that last up to 3 years and can be replaced so important life history parameters of this long-lived and infrequently breeding species can be determined.

The apparent broad habitat preferences of POPs for rocky and riparian areas has resulted in its invariable intersection with mining operations and infrastructure corridors, resulting in numerous EPBC referrals. Consultants working on behalf of resource companies to survey and monitor POPs have struggled to locate pythons and have not developed effective ways to monitor the impacts of mining activity on the species.

The monitoring of snake populations has been largely unsuccessful using standard vertebrate techniques such as mark-recapture or sighting surveys (Boback, Nafus, Adams and Reed 2019; Henderson, Hileman, Sajdak, Harrison, Powell and Bradke 2019). Several monitoring techniques have been/or are continuing to be trialled. Road transects generally encounter few pythons and so have no power to detect population changes or calculate population estimates. Automatic cameras at rockholes or waterpoints rely on infra-red and very rarely detect slow-moving pythons whose skin temperatures may not be dramatically different from ambient. The monitoring of rock-wallabies or quolls as a surrogate metric for POPs have their own methodological issues to obtain reasonable estimates. POPs have such a diverse recorded diet that any link between their population size and trends and the abundance of these two mammal species is unlikely to be very informative.

The collection of eDNA from waterbodies has been examined for monitoring, however Weeks and Tingley (2017) were unable to detect POP eDNA in 26 water bodies known to be frequented by POPs. Better knowledge of the species biology would assist in deciding when and where to collect water samples to detect POPs with eDNA. They appear to spend comparatively little time sitting in water and further, this tends to be in summer months when thunderstorms and cyclones lead to be elevated river flows (Pearson, unpublished; Tutt *et al.* 2002; Tutt *et al.* 2004) and likely strong dilution of any python eDNA in waterbodies.

A project is needed that resolves the unknown life history parameters of POPs important for its conservation; identifies threats to its current populations; and investigates effective monitoring techniques that help understand how land management actions (fire, feral predator control) may maintain or re-establish populations, as well as reveal any impacts of mining and other land uses (stock grazing) so that mitigation actions can be adopted if required.

The project will be funded from existing offset POP funds, with the possibility of further funds becoming available from other offsets. These could benefit the project with the additional of staff that would enable telemetry and monitoring techniques to be run in different seasons and over longer time scales.

Strategic Context:

Advice on Lialis olivaceus barroni (Threatened Species Committee 2008) as outlined below:
Research priorities that would inform future regional and local priority actions include:

1. Design and implement a monitoring program.
2. More precisely assess population size, distribution, ecological requirements and the relative impacts of threatening processes.
3. Undertake survey work in suitable habitat and potential habitat to locate any populations/occurrences.

The project is consistent with a number of the DBCA Animal Science Program activities including:

1. Address knowledge gaps to inform the effective conservation of threatened fauna species.
2. Provide scientific knowledge to ensure the effective and efficient monitoring of fauna species.
3. Identify, assess and apply emerging technologies and innovative approaches to fauna conservation research.
4. Engage with the community to identify opportunities for involvement in fauna conservation research and to encourage knowledge transfer.
5. Build capacity to deliver fauna conservation outcomes by collaborating with other science providers, government agencies, industry and NGOs.

The project aligns with the seven projects identified by Pearson and Morris (2011) in "Project Plan- The ecology and conservation of the Pilbara Olive Python 2011-2016" (Department of Parks and Wildlife):

1. Review of published and unpublished literature
2. Development of survey and monitoring techniques
3. Pilbara Olive Python genetics and population structure
4. Detailed field ecology of Pilbara Olive Pythons
5. Developing strategies to minimise Pilbara Olive Python mortality

6. Reducing the impact of mining and infrastructure on Pilbara Olive Pythons
7. Monitoring Pilbara Olive Python populations

A POP workshop was held in Perth in 2013 and identified the following research requirements:
1. Undertake a literature review; 2a. Develop survey techniques; 2b. Develop monitoring techniques: 2c. Better understand habitat requirements: 2d. Better understand breeding biology; 3a. Better understand prey relationships; 3b. Better understand predator relationships.

The proposed project examines the most critical of the research priorities identified by these three documents, focusing on:

1. Reviewing available literature
2. Undertaking detailed ecological work to understand habitat requirements, diet and reproduction
3. Supporting efforts to resolve population relationships and structure with genetic techniques
4. Identifying conservation threats
5. Developing and testing survey/monitoring techniques.

The project has a projected life of three years, but may require an extension of work on reproduction for a further 2-3 years on account of the apparent low reproductive frequency of female POPs.

Aims

1. Collate existing information about the Pilbara Olive Python biology and management including 2013 workshop proceedings and publish.
2. Document the field ecology of POPs focussing on habitat preferences and life history characteristics (diet, shelter sites, juvenile mortality, reproductive frequency, etc.) likely to be influential in population dynamics and impacted by threats such as wildfire, grazing and mining activities
3. Undertake experiments to determine threats to juveniles, the population cohort likely to be most affected by feral animal predation or habitat changes due to fire or grazing.
4. Trial, investigate and improve survey and monitoring techniques to enable better assessment and mitigation of potential impacts of resource projects and other land uses on Pilbara Olive Pythons.

Expected outcome

1. The collation and publication of existing and new research on the biology of POPs relevant to the ongoing conservation and monitoring of this threatened species, in particular, identifying habitat requirements, diet, reproductive behaviour and conservation threats.
2. Experimental trials with models to assess predation threats to different cohorts of pythons in different habitats with publication of an updated consideration of its conservation status and the relevant conservation threats.
3. The testing of a variety of monitoring techniques for determining population trends in POP populations and the impact of disturbance, especially from mining operations, infrastructure development and fire.
4. Collaboration with a range of stake-holders to maintain POP populations across a variety of land tenures and raise awareness in the general public about this iconic Pilbara python.
5. Assistance and collaboration with researchers working on POP eDNA projects.

Knowledge transfer

Information obtained during the project will be transferred to DBCA staff, other Government agencies, landholders, mining companies, environmental consultants and indigenous rangers and land councils in several ways:

1. Collaboration during fieldwork with DBCA staff, indigenous rangers and environmental consultants, giving these groups field experience with POPs, their habitats and in the assessment of threats to their conservation. Wherever possible, I will involve these people in python radio-telemetry and any trials of monitoring techniques.
2. Workshops and presentations to DBCA staff, indigenous ranger groups, mining companies and scientific audiences at conferences.
3. Informal meetings organised in Aboriginal communities.
4. Articles in the popular press and magazines such as Landscope and newspaper articles designed to inform the public about the species and conservation actions.

5. Production of peer-reviewed publications in scientific journals.
6. Contribution to any reviews on the conservation status of the species by State or Federal agencies and the formulation of monitoring and research requirements for new and existing resource projects.

Tasks and Milestones

1. Obtain Animal Ethics approval for the project- October 2021
2. Reconnaissance trip to select study sites and discuss the project with DBCA staff, mining companies and indigenous land councils to ensure land access and sort out logistical issues- October/November 2021
3. Commence capture and implanting transmitters in POPs and undertake experimental trial of predation of juvenile POPs- January 2022
4. Publication of existing biological information on POPs and an update of the 2013 workshop on research requirements- June 2022
5. Submission of paper on the outcome of trials on sources of predation of juvenile POPs- December 2022
6. Comparison of detection and monitoring techniques based on walked searches, head-torch surveys, eDNA (water and faecal pellets) and road transects with publication by December 2023.
7. Radio-telemetry of POPs at three or four sites to document habitat preferences, microhabitat use, diet, reproductive behaviour and sources of mortality (January 2022-July 2024).
8. Initial workshops and meetings with staff, indigenous groups and mining companies to report on preliminary results of radio-tracking work and the final results of comparison of monitoring techniques- November 2024.
9. Submission of papers on reproductive strategy, diet, foraging ecology and monitoring techniques- April 2025.
10. Final workshops and meetings with staff, indigenous groups and mining companies to disseminate research findings in June 2025.

References

Bateman, P.W., Fleming, P.A. and Wolfe, A.K. (2017). A different kind of ecological modelling: the use of clay model organisms to explore predator-prey interactions in vertebrates. *Journal of Zoology* **301**: 251-262.

Bittner, T.D. (2003). Polymorphic clay models of *Thamnophis sirtalis* suggest patterns of avian predation. *Ohio Journal of Science* **103**: 62-66.

Boback, S.M., Nafus, M.G., Yackel Adams, A.A. and Reed, R.N. (2020). Use of visual survey and radiotelemetry reveals sources of detection bias for a cryptic snake at low densities. *Ecosphere* **11**: e03000. 10.1002/ecs2.3000.

Brodie III, E.D. and Janzen, F.J. (1995) Experimental studies of coral snake mimicry: Generalized avoidance of Ringed Snake patterns by free-ranging avian predators. *Functional Ecology* **9**: 186-190.

Carlisle, J.D., Hoffman, A.S. and McDonald, T.L. (2018). Beginners line-transect analysis in Rdistance. https://cran.r-project.org/web/packages/Rdistance/vignettes/Rdistance_BeginnerLineTransectCovar.pdf

Department of Parks and Wildlife (2013). Proceedings of the Pilbara Olive Python workshop, Kensington, December 10 2013.

Foster, S.D. (2020) MBHdesign: An R-package for efficient spatial survey designs. *Methods in Ecology and Evolution* **12**: 415-420. **https://doi.org/10.1111/2041-210X.13535**

Henderson, R.W., Hileman, E.T., Sajdak, R.A., Harrison, B.C., Powell, R. and Bradke, D.R. (2020). Effects of body size, diet and transience on the demography of the arboreal boid snake *Corallus grenadensis* on Carriacou (Grenada Grenadines, West Indies). *Population Ecology* **2021**: 1-12.

Lind, A.J., Welsh, H.H. and Tallmon, D.A. (2005). Garter snake population dynamics from a 16-year study: Considerations for ecological monitoring. *Ecological Applications* **15**: 294-303.

Leonard, J. Analysing wildlife telemetry data in R. https://www.ckwri.tamuk.edu/sites/default/files/publication/pdfs/2017/leonard_analyzing_wildlife_telemetry_data_in_r.pdf accessed 28/6/2021.

Nordberg, E.J. and Schwarzkopf, L. (2019). Predation risk is a function of alternative prey availability rather than predator abundance in a tropical savanna woodland ecosystem. *Scientific Reports* **9**: 7718. https://doi.org./10.1038/s41598-019-44159-6

Pearson, D.J. (1993). Distribution, status and conservation of pythons in Western Australia. In: D. Lunney and D. Ayers (Eds.) *Herpetology in Australia: A diverse discipline*. Surrey Beatty, Sydney.

Pearson, D. (2006). Giant pythons of the Pilbara. *Landscope* **19**: 32-39.

Pearson, D. (2007) Pilbara Olive Python, *Liasis olivaceus barroni*. In M, Swan (Ed.) Keeping and Breeding Australian Pythons. Swan Herp Books, Victoria.

Pearson, D. and Shine, R. (2002). Expulsion of intra-peritoneally-implanted radio-transmitters in Australian pythons. *Herpetological Review* **33**: 261-263.

Pearson, D., Shine, R. and How, R. (2002). Sex-specific niche partitioning and sexual size dimorphism in Australian pythons (*Morelia spilota imbricata*) *Biological Journal of the Linnean Society* **77**: 113-125.

Pearson, D., Spencer, P., Hillyer, M. and How, R.A. (2013). Genetic survey of the Pilbara Olive Python: Final report. Unpublished report, Murdoch University.

Seaman, D.E. and Powell, R.A. (1996). An evaluation of the accuracy of kernel density estimators for home range analysis. *Ecology* **77**: 2075-2085.

Smith, L.A. (1981). A revision of the *Liasis olivaceus* species-group (Serpentes: Boidae) in Western Australia. *Rec. WA Museum* **9**: 227-233.

Steen, D.A. (2010). Snakes in the Grass: Secretive natural histories defy both conventional and progressive statistics. *Herpetological Conservation and Biology* **5** (2): 183-188.

Threatened Species Committee (2008). Approved Conservation Advice for Liasis olivaceus barroni (Olive Python-Pilbara subspecies). www.environment.gov.au/cgi-bin/sprat.public/publicspecies.pl?taxonid=66699.

Tutt, M. Fekete, S., Mitchell, S., Brace, P. and Pearson, D. (2004). Unravelling the mysteries of Pilbara Olive Python Ecology. Final Report to WWF. Threatened Species Network Community Grants, Project WA 11/101, 44 pages.

Tutt, M., Mitchell, S., Brace, P. and Pearson, D. (2002). Conserving Pilbara Olive Pythons on the Burrup. Annual report to WWF. Threatened Species Network Community Grants Annual Report, Project WA 04/100, 38 pages.

Ward, R.J., Griffiths, R.A., Wilkinson, J.W. and Cornish, N. (2017). Optimising monitoring efforts for secretive snakes: a comparison of occupancy and N-mixture models for assessment of population status. *Scientific Reports* (2017) 7: 18074. DOI:10.1038/s41598-017-18343-5.

Weeks, A. and Tingley, R. (2017). Monitoring the Pilbara Olive Python using environmental DNA. Report prepared for Rio Tinto by Cesar Pty. Ltd., 32 pages.

Worton, B.J. (1989). Kernel methods for estimating the utilization distribution in home range studies. *Ecology* **70**: 164-168.

Study design

Methodology

The project will use a variety of techniques to answer various aspects as outlined below:

1. *Documenting habitat preferences, diet, home range and reproductive behaviour*

Radio-telemetry will be the primary method used. Surgically implanted temperature-sensitive radio-transmitters (Holohil) will be placed into pythons using the technique of Reinhert and Cundall (1982) with modifications suggested by Pearson and Shine (2002). Pythons will be tracked on an occasional basis throughout much of the year, with more intensive tracking during periods of mating, nesting and at the time of dispersal of young. Faecal pellets will be gently palpated from pythons whenever they are handled for the purpose of measurement or surgical implants to assist with documenting the diet.

Each time a python is located, its behaviour, body posture, body temperature and a range of environmental factors (vegetation type, microhabitat, air temperature) along with its location with a GPS will be recorded. Any faecal pellets that are located will be collected for use in dietary analysis. An automatic logger and receiver may be used to record incubation temperatures of brooding females and environmental temperatures.

2. *Investigation of predation threats to juvenile pythons*

Previous radio-tracking of 14 adult POPs did not result in the loss of any individuals to predators (Pearson, unpublished). As adults they are probably almost invulnerable to predators (without the possible exception of dogs, known to take adult carpet pythons in NSW; M. Fitzgerald, pers. comm.) Neonate and other juvenile cohorts are generally too small to implant with radio-transmitters, so I propose to trial of 'NanoTags' and 'Nano-pins' (Lotek) to track juveniles. It is planned that if any radio-tagged females lay eggs, the surrounds of the nest will be fenced to capture the neonates when they begin to disperse and monitored with regular visits and trail cameras. The small transmitters would be glued on with tissue adhesive to enable tracking over a few weeks to record their habitat preferences, dispersal and potentially predation events.

The other technique for investigating possible predators is the use of rubber or plasticine models (Brodie and Janzen 1995; Bittner 2003; Bateman, Fleming and Wolfe 2017; Nordberg and Schwarzkopf 2019) in the shape and colour of small pythons and placed in various microhabitats and positions to mimic real pythons. These models are then monitored to determine what predators are likely to attack small pythons. Trail cameras would be the primary monitoring tool for this, but inspection of the models for claw or teeth marks could be informative if the cameras fail to detect certain predators (such as snakes or goannas). At least five models would be set up in each microhabitat type with controls out in the open and run for five days (or longer if there are no initial attacks).

3. *Reproductive frequency in female POPs*

Limited radio-tracking found that while male POPs are reproductively active every year, females probably breed less frequently, perhaps only every 3-4 years. The process of developing eggs and incubation can result in the loss of around half of the initial weight of female carpet pythons (Pearson, Shine and How 2002), and this is likely to be also similar for the POP. Post-incubation female pythons are typically thin with poor muscle tone and may be more susceptible to mortality from disease or a failure to capture prey to recover body condition. Consequently, it may take a female POP several years to build up sufficient fat bodies to breed again.

Close-order radio-tracking will be undertaken of gravid females to determine reproductive frequency, locate their nests and to calculate the approximate hatching time for young to investigate juvenile dispersal (see point above). Once eggs have hatched, the egg shells will be recovered if feasible to record clutch size and potentially have them tested to see if the clutch was fathered by more than one male python.

3. Comparison of monitoring techniques

Detailed records will be kept on all search techniques used to locate pythons to provide data for a comparison of potential techniques. In addition, transects by day and at night (at least 10 per paired site) will be undertaken at study areas where telemetered pythons are present to assess the efficacy of visual surveys. Similarly, road driving transects will be used at Millstream NP where a ring road passes through an extensive area of POP habitat to determine the usefulness of this technique for locating and monitoring POPs.

The use of eDNA has been trialled for monitoring POPs but remains in its infancy as a technique. Curtin University (Prof Morten Allentoft and Dr Nicole White) have a proposed three-year project on eDNA monitoring and Biota Consulting also has a project looking at the use of genetic techniques for monitoring POPs. I will work with these groups to supply tissue and collaborate on papers/reports.

Biometrician's Endorsement

required

Data management

No. specimens

Herbarium Curator's Endorsement

not required

Animal Ethics Committee's Endorsement

required

Data management

Radio-telemetry data will be entered into an Access database and analysed by various available packages on Program R (Leonard 2021). Non-parametric Kernel analysis will be the primary method used to examine home range differences. Data will be uploaded into Departmental databases for storage during and at the completion of the project.

Camera imagery will be examined and manipulated using the Program CPW with subsequent analysis of simple datasets in Excel or routines within R. Some GLMM modelling will be undertaken of data collected during model trials to examine the influence of microhabitat, season, time of day and possible interactions between these factors in explaining observed predation events.

Transect sampling will be analysed with Rdistance (Carlisle, Hoffman and McDonald 2018) or perhaps the newly available MBHdesign (Foster 2021) within R. I will liaise with colleagues within and outside the Department to keep abreast of the new packages available in R and how they can be used to provide more informative analyses.

Budget

Consolidated Funds

Source	Year 1	Year 2	Year 3
FTE Scientist	0.6	0.6	0.6
FTE Technical			
Equipment			
Vehicle			
Travel			
Other			
Total	0.6	0.6	0.6

External Funds

Source	Year 1	Year 2	Year 3
Salaries, Wages, Overtime			
Overheads			
Equipment	10 000	5 000	5 000
Vehicle	20 000	20 000	20 000
Travel	10 000	10 000	10 000
Other		5 000	5 000
Total	40 000	40 000	40 000