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1. INTRODUCTION

1.1. Background

Ficopomatus enigmaticus (Fauvel 1928) is an estuarine and brackish-water serpulid polychaete. Its native biogeographic range is not fully understood. However, it is non-indigenous to New Zealand and was first recorded in 1967 when it began to form extensive nuisance growths on coastal infrastructure in upper Whangarei Harbour (Cranfield et al. 1998; Read & Gordon 1991). In 1993, the species was discovered in Hawke's Bay, where it fouled a flood protection pumping station that discharges stormwater into the Ahuriri Estuary (Probert 1993).

Ficopomatus enigmaticus remained at relatively low levels of abundance in the Napier region for more than a decade. However, from 2010, local populations boomed. Over the last decade, *F. enigmaticus* has formed extensive growths (including biogenic 'reefs') on artificial infrastructure in the region including revetments, bridges, and stormwater pumping stations, as well as in natural habitats such as the seafloor in the Ahuriri estuary. Infestations became so prolific that in 2017, Hawke's Bay Regional Council (HBRC) undertook a local control operation, during which approximately 600 tonnes of worm biomass were excavated from a localised reef cluster in the Ahuriri estuary.

The impacts of current worm infestations in HBRC's jurisdiction have not yet been quantified but overseas incursions of *F. enigmaticus* indicate the potential for significant ecological (e.g., habitat and trophic losses for soft-sediment dwelling species) and economic effects (e.g., partial or full loss of functionality for civic/industrial pump, turbine and water cooling systems) (Bazterrica et al. 2011; Dittmann et al. 2009; Miranda et al. 2016; Schwindt et al. 2001; Weitzel 2021). Due to the considerable ecological and cultural values associated with the Ahuriri estuary and other regional waterbodies, and the reliance of the region on stormwater pumping stations for flood protection, HBRC are concerned about further expansion of local *F. enigmaticus* populations and potential wider geographical spread. A precedent of rapid spread exists for other global areas, including coastal lagoons in Argentina (Schwindt et al. 2004) and the Po River delta in Italy (Bianchi & Morri 2001, 1996). In the latter, the extent of *F. enigmaticus* reefs increased from 15 to over 200 hectares within 2 decades. By comparison, *F. enigmaticus* populations in the Napier region are relatively modest in extent. This might represent a unique opportunity for control to be effective, if undertaken soon.

In December 2021, via an MBIE Envirolink Small Advice Grant, HBRC engaged Cawthron Institute to help identify options and opportunities for the potential control of *F. enigmaticus*.

1.2. Project scope and activities

The main objectives of the project were:

- to convey to Cawthron Institute biosecurity and polychaete experts an understanding of the scale of local *F. enigmaticus* infestations, enabling them
- to provide recommendations regarding research activities needed to inform decisions around pest management for the invasive worm.

On 1 December 2021, two Cawthron scientists visited the council. The first half of the day was spent with visits to *F. enigmaticus* infestation sites in the Clive River and the Ahuriri Estuary/Te Whanganui-a-Orotū. During the remainder of the visit, HBRC personnel presented historical photographs, aerial imagery and mapped distributions of *F. enigmaticus* in the Napier region, as well as images, footage and operational details of a recent control campaign in the Ahuriri Estuary.

Based on the information provided and conversations during the visit, it was agreed that Cawthron would provide this short report to describe the initial research activities that we recommend should be undertaken to enable the development of a control strategy for *F. enigmaticus*.

2. INFORMATION NEEDS TO UNDERPIN DECISION-MAKING REGARDING *FICOPOMATUS* MANAGEMENT

We consider the following items key to decision-making and development of a potential control programme for *F. enigmaticus* in the Napier/Hawke's Bay region:

- **Regional invasion history, current distribution, and rate of expansion.** This information helps with prioritising target locations for control efforts and with measuring level of success. It is largely available following HBRC's efforts to date in quantifying and monitoring the regional distribution of *F. enigmaticus*.
- **Understanding of reproductive biology, seasonality and dynamics.** Mechanical or chemical treatment and removal methods can result in the release of propagules from targeted populations. This has the potential to exacerbate local rates of recruitment and recolonisation, thereby undermining control efforts. This is a particularly important consideration in the case of *F. enigmaticus*, given its high levels of fecundity and possibly multiple annual spawning events. While useful data exist on the reproduction of *F. enigmaticus* in other global locations, there is no understanding of the worm's reproductive patterns in the Napier region. Invasive populations often display seasonal dynamics different from those in other regions (Bianchi & Morri 1996; Dixon 1981; Obenat et al. 2006). The success of population control efforts is highly dependent on timing in relation to the

reproductive status of target populations. This is important for species such as *F. enigmaticus* that may spawn multiple times per year (Bianchi & Mori 1996; Leone 1970; Zuraw & Leone 1968). In addition, and to support risk assessment with regard to future spread and distribution, information on life history traits including fecundity, larval duration and settlement ecology is important.

- **Feasibility assessment of potential approaches to population control.** Numerous approaches have been used over the past decades for control or attempted eradication of marine invasive species. They include the use of chemical agents (e.g. descalers, chlorine, bromide and many others), mechanical methods (removal, suffocation, osmotic shock and others) and biological control agents. Their efficacy depends on the type, size, distribution and location of target populations, as well as other factors including previous success rates, cost, health and safety risks, environmental risks and regulatory approval. Potential candidate control agents and methods need to be subjected to a defined set of feasibility criteria so that potentially useful approaches can be identified and shortlisted for pilot trials. To our knowledge, this information has not yet been collated for *F. enigmaticus* in New Zealand.

Additional information would be useful, perhaps required, for the development and justification of a longer-term pest management strategy:

- **Environmental tolerance range and risk of geographic spread in changing climatic conditions.** The development of a regional pest management strategy (and its overall resourcing) may be particularly justified if anticipated climate/environmental change trajectories for the Hawke's Bay region (or other New Zealand regions) indicate a risk of increased geographic spread of *F. enigmaticus*. This information is currently not available but could be obtained using species distribution modelling approaches.
- **Other mechanisms of spread.** Ideally, populations targeted for control should be contained as far as possible so that spread to other environments (undermining control efforts) is prevented. To our knowledge, no data exist for rates and distances of human-assisted transport (e.g. hull biofouling, translocation of submerged equipment and infrastructure, aquarium collections and disposals) of *F. enigmaticus* in the Napier region.
- **Values at risk from current-day or increasing infestations of *Ficopomatus*.** This should include the types and magnitudes of ecological, economic, social and cultural impacts resulting from regional infestations, and an understanding of the values at risk. This informs cost-benefit assessments and decision-making regarding priority, scale and resourcing of interventions.
- **Cost-benefit assessment of pest management.** This exercise allows decision-makers to weigh up the costs of a control programme (personnel, resources, collateral effects, etc.) against the costs of not undertaking it (impacts on local/regional values, as described above), over meaningful time scales.

Drawing on the information needs presented above and our understanding of current data availability, the following section outlines specific research activities that would need to be carried out to enable us (or other qualified research providers) to make recommendations regarding a potential control programme for *F. enigmaticus* in the Napier region.

2.1. Priority research activities to enable fundamental decisions and design of a control programme

1. **Determination of reproductive seasonality of *F. enigmaticus* in the Napier region.** We recommend the implementation of a temporal monitoring programme for reproductive seasonality in key areas of infestation. This programme could include two components. A first one is the use of artificial settlement collectors, such as tiles made from clay, plastic, fibro-cement or other suitable materials, to examine seasonal patterns of recruitment. This component is of primary importance. A second, parallel component could be the repeated (e.g. monthly) collection of adult worms to assess reproductive status (e.g. presence/release of gametes, fecundity, hermaphroditism). This component is also useful, but more time-consuming, and of secondary importance. These monitoring activities should take place over at least 1 year before decisions can be made, but preferably the programme should continue for 2 years or longer to capture potential interannual variability.

   The outcome of this activity would be the ability to identify 'temporal windows' for potential control operations, where reproductive activity is unlikely to compromise success.

   We suggest that a cost-effective approach for this research activity would be:
   - design of the collector arrays and experimental design—Cawthron and HBRC
   - deployment, retrieval and exchange of collectors on (e.g.) a monthly basis—HBRC (possibly with participation from local schools or conservation agencies as feasible)
   - sample analysis (preserved collectors, specimens and/or photographs), data analysis and interpretation—Cawthron.

2. **Review of global distribution and ecology, and case studies of *F. enigmaticus* invasion.** Extensive nuisance growths of *F. enigmaticus* have been reported from Argentina, the Azores, Italy, the Baltic Sea and other locations. We recommend that a review of global case study literature and communication with relevant international experts is carried out to determine:
   - the scale and timeframes of invasion or population explosion events
   - habitat types affected and magnitude of impacts

- methods, implementation and outcomes of any control attempts undertaken.

We recommend that this review also includes the collation of global occurrence records (e.g. the Ocean Biodiversity Information System [OBIS] contains over 300 records already) and environmental information (e.g. temperature, salinity, habitat) associated with the species' global distribution. When needed, data on current distribution and environmental association could then be combined with environmental change predictions to develop species distributions models that predict the potential future range of *F. enigmaticus* around New Zealand.

Cawthron could undertake this component cost-effectively. Our team's literature collection includes a considerable proportion of global case studies, and Dr Wolf has existing relationships with global authorities on sabellid taxonomy and pest management. Our team has also developed other species distribution models, which could be adapted for determination of the potential future range of *F. enigmaticus* in New Zealand, to support cost-benefit assessment of control.

3. **Systematic assessment of potential approaches to population control.** We recommend that a third research activity involves the identification of potential candidate approaches for *F. enigmaticus* control, and the systematic assessment of each approach against a suite of meaningful feasibility criteria.

   Candidate approaches should include:
   - physical/mechanical techniques (e.g., excavation, crushing, smothering, heat)
   - chemical approaches (e.g., biocides, osmotic shock)
   - combinations of both
   - others as identified.

   Feasibility criteria should include:
   - history of application (scales and success rates)
   - likely effectiveness for sessile tubeworms at scales relevant to the Napier region
   - collateral effects
   - health and safety risks
   - regulatory approval
   - biosecurity risks
   - cost
   - bulk availability.

   Relative weightings can be applied to the various criteria, based on HBRC's needs and preferences. The outcome of this assessment would be a shortlist of approaches that could be considered for initial trials if a control programme were to be implemented.

We consider it most cost-effective if this this activity were undertaken by Cawthron, since our team has recently produced similar assessments for the treatment of biofouling on maritime vessels and coastal infrastructure (e.g. Cahill & Floerl 2019) and is preparing a related activity for the aquaculture sector.

4. Subsequent synthesis of research activities (1) – (3) will then enable us to:
    - Recommend whether regional (large-scale) or localised control of *F. enigmaticus* is *biologically and operationally* feasible given present-day extent and availability of potential control methods.
    - If control is deemed as a feasible option, develop (with HBRC) a strategy and experimental plan for a control programme with specified objectives. This would likely include a hierarchical approach that starts with lab- or field-based pilot trials (to develop operational parameters and protocols) and may then expanded to larger-scale treatment or removal campaigns.

    Depending on HBRC's requirements this process could also include (or be preceded by) additional activities that may be required to justify a control programme, such as quantification of values at risk (ecological, economic and/or social); modelling the potential future range of *F. enigmaticus*, and cost-benefit assessment of control measures (see Section 2).

3. NEXT STEPS

Should HBRC wish to consider Cawthron Institute for implementing research activities (i) – (iv) in Section 2.1, we suggest further dialogue to agree on which elements HBRC would prefer to contract out vs. carry out in-house. We are then able to provide a budget for these activities and assist HBRC with preparing applications or presentations to secure funding, as needed.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

Bazterrica MC, Botto F, Iribarne O 2011. Effects of an invasive reef-building polychaete on the biomass and composition of estuarine macroalgal assemblages. Biological Invasions 14: 765–777. https://doi.org/10.1007/s10530-011-0115-7

Bianchi CN, Morri C 2001. The battle is not to the strong: serpulid reefs in the Lagoon of Orbetello (Tuscany, Italy). Estuarine, Coastal and Shelf Science 53: 215–220. https://doi.org/10.1006/ecss.2001.0793

Bianchi CN, Morri C 1996. *Ficopomatus* “reefs” in the Po River delta (Northern Adriatic): their constructional dynamics, biology, and influences on the brackish-water biota. Marine Ecology 17: 51–66.

Cahill P, Floerl O 2019. Reactive treatment approaches for biofouling in internal seawater systems of large commercial vessels. Report prepared for the Australian Government Department of Agriculture and Water Resources. 71 p.

Cranfield HJ, Gordon DP, Willan RC, Marshall BA, Battershill CN, Francis MP, Nelson WA, Glasby CJ, Read GB 1998. Adventive marine species in New Zealand. NIWA, Wellington. 48 p.

Dittmann S, Rolston A, Benger SN, Kupriyanova EK 2009. Habitat requirements, distribution and colonisation of the tubeworm *Ficopomatus enigmaticus* in the Lower Lakes and Coorong. Report for the South Australian Murray-Darling Basin Natural Resources Management Board, Adelaide. 99 p.

Dixon DR 1981. Reproductive biology of the serpulid *Ficopomatus (Mercierella) enigmaticus* in the Thames Estuary, SE England. Journal of the Marine Biological Association of the United Kingdom 61: 805–815. https://doi.org/10.1017/S0025315400048220.

Leone DE 1970. The maturation of *Hydroides dianthus*. Biological Bulletin 138: 306–315. https://doi.org/10.2307/1540214

Miranda NAF, Kupriyanova EK, Rishworth GM, Peer N, Bornman TG, Bird MS, Perissinotto R 2016. An invasive polychaete species found in living marine stromatolites. Aquatic Invasions 11: 257–266. https://doi.org/10.3391/ai.2016.11.3.04.

Obenat S, Spivak E, Orensanz JM 2006. Reproductive biology of the invasive reef-forming serpulid, *Ficopomatus enigmaticus*, in the Mar Chiquita coastal lagoon, Argentina. Invertebrate Reproduction and Development 49: 263–271. https://doi.org/10.1080/07924259.2006.9652216.

Probert PK 1993. First record of the introduced fouling tubeworm *Ficopomatus enigmaticus* (Polychaeta: Serpulidae) in Hawke Bay, New Zealand. New Zealand Journal of Zoology 20: 35–36. https://doi.org/10.1080/03014223.1993.10423240.

Read GB, Gordon DP 1991. Adventive occurrence of the fouling serpulid *Ficopomatus enigmaticus* (Polychaeta) in New Zealand. New Zealand Journal of Marine and Freshwater Research 25: 269–273.

Schwindt E, Bortolus A, Iribarne OO 2001. Invasion of a reef-builder polychaete: direct and indirect impacts on the native benthic community structure. Biological Invasions 3: 137–149.

Schwindt E, De Francesco CG, Iribarne OO 2004. Individual and reef growth of the invasive reef-building polychaete *Ficopomatus enigmaticus* in a south-western Atlantic coastal lagoon. Journal of the Marine Biological Association of the United Kingdom 84: 987–993. https://doi.org/10.1017/S0025315404010288h.

Weitzel, B 2021. Ecology of the invasive species *Ficopomatus enigmaticus* (Fauvel, 1923) in an estuary of the southern Baltic Sea. PhD thesis, Leipzig Institute of Baltic Sea Research.

Zuraw EA, Leone DE 1968. Laboratory culture of the tubeworm, *Hydroides (Eupomatus) dianthus* Verril 1873. General Dynamics, Electrical Boat Division, Groton Connecticut.