Summary of Information Relating to the Introduction and Spread of Pacific Oysters in South West Estuaries

Context of this Information Summary

This information summary has been compiled by Devon and Severn Inshore Fisheries and Conservation Authority (D&S IFCA) to be shared with the Duchy of Cornwall in relation to farming of Pacific oysters (*Magallana gigas*), particularly in the Dart and Devon Avon estuaries.

D&S IFCA is a statutory regulator. Collectively, the IFCAs are responsible for the sustainable management of sea fisheries resources in English waters from baselines out to six nautical miles.

D&S IFCA's Authority is comprised of Local Authority representatives, local stakeholders with marine and fisheries expertise, and nominees from Natural England, the Environment Agency and the MMO. D&S IFCA's funding is provided by Local Authorities and directly by Defra. There is also a team of Officers who conduct the day-to-day operations to deliver the shared IFCA Vision, to "*lead, champion and manage a sustainable marine environment and inshore fisheries, by successfully securing the right balance between social, environmental and economic benefits to ensure healthy seas, sustainable fisheries and a viable industry*."

The powers and duties of the IFCAs are provided by the Marine and Coastal Access Act 2009 (the Act). The IFCAs' main legal duties are described in section 153 of the Act. They must manage the exploitation of sea fisheries resources in their Districts, balancing the social and economic benefits of exploiting the resources of sea fisheries in their Districts with the need to protect the marine environment, or help it recover from past exploitation. Under Section 154 of the Act, IFCAs must seek to ensure the conservation objectives of any MCZs in the District are furthered.

While also considering the wider environment, much of the information in this summary is provided in relation to Marine Protected Areas (MPAs) and with an emphasis on its application to south Devon, including the Dart and Devon Avon Estuary Marine Conservation Zones (MCZs).

In considering potential impacts of Pacific oyster aquaculture on MPAs, a particular focus has necessarily been on the potential for "introduction or spread of invasive non-indigenous species", which has previously been identified as a source of concern for some local stakeholders, and a potential pressure on MPAs.

Introduction of Pacific Oysters to Sites

Wild settlement of Pacific oysters on the south coast of England is advanced (Morgan *et al*., 2021) and they are reported as present on sediments in the Dart and Devon Avon Estuaries (Morgan *et al*., 2021). There are high densities on sediment and rocky habitats in parts of the Fal Estuary, Fowey Estuary, Plymouth Sound and Yealm Estuary (Morgan *et al*., 2021), therefore it can be confidently concluded that there is an established wild population of Pacific oysters in the estuaries of the South Devon and Cornwall coast. This includes many areas where Pacific oyster aquaculture is thought never to have occurred (for example, within Plymouth Sound and Estuaries Special Area of Conservation (SAC)).

Therefore, Pacific oysters are already 'introduced' as a wild species in the area; while the origin of this introduction is not known for certain, the introduction has already occurred and the current aquaculture activity poses no risk of the *introduction* of this species, which is the pressure benchmark within relevant MPAs. This is supported by a recent Habitats Regulations Assessment (HRA) conducted by Cefas Fish Health Inspectorate (FHI) for activities in the Devon Avon (HRA attached) (FHI, 2023). This HRA demonstrated that the activities would have no significant adverse effect on the nearby Start Point to Plymouth Sound and Eddystone SAC via introduction of Pacific oysters, a conclusion that Natural England as the Statutory Nature Conservation Body has agreed with (FHI, 2023). The same conclusion has been demonstrated in MCZ assessments conducted by D&S IFCA for the Dart Estuary MCZ and the Devon Avon Estuary MCZ (assessments currently being finalised, not yet submitted to Natural England for formal advice). It should be noted that there is no statutory requirement for FHI to conduct MCZ assessments for *existing* aquaculture activities in MCZs; the requirement for an assessment is only triggered at the point of authorisation.

In summary, the introduction to the region has already occurred. Furthermore, it is recognised in Defra policy (attached) (Defra, 2022) that Pacific oysters are well established south of 52°N latitude and that, "*with current technology, Pacific oyster cannot be prevented from establishing in, or be successfully or economically eradicated from, this area."* The Dart and Devon Avon Estuaries' Pacific oyster aquaculture sites are between 50°N and 51°N latitude. Therefore, Defra is in support of Pacific oyster aquaculture in these areas, having stated that "*authorisations for farms within 5km of MPAs will continue to be granted only after the regulator has considered the outcome of site based environmental impact assessments. These assessments will take into account the impact of Pacific oysters on the current condition of local MPAs".*

Importantly, Defra's policy also identifies the actions that would be supported if MPA assessments suggest that Pacific oyster aquaculture will have an adverse impact on those MPAs: "*If Pacific oysters are likely to have an adverse impact on these sites, Defra supports regulators to introduce mitigating authorisation conditions, such as triploidy or monitoring."* Clearly, these actions stop short of ceasing aquaculture of Pacific oysters, which are identified by Defra as "*an important species for the aquaculture industry with potential for growth*".

Spread of Pacific Oysters

Pacific oyster aquaculture is thought by some to have the potential to exacerbate the development of existing wild populations, particularly by contributing larvae following spawning events. However, recent evidence from scientific reports and MPA assessments demonstrates that any contribution of aquaculture to spread of Pacific oyster will likely be swamped by the contribution from wild populations. This evidence is summarised below.

Pacific Oysters produce vast numbers of eggs and larvae, which are planktonic and therefore could drift from source populations into adjacent areas with natural water movements. However, larval mortality is expected to be as high as 99% (see Teixeira Alves *et al.*, 2021, attached, and references therein), during a larval stage that lasts several weeks before settlement is possible, and the distribution of surviving larvae is largely dependent on local/regional water movement patterns. With such a long larval stage, it is possible that surviving locally spawned larvae will become highly dispersed outside of their 'home' estuary, with local settlement being dominated by more-developed settlers spawned elsewhere (Carlon and Olson, 1993; Guy *et al.*, 2019).

As highlighted above, there is an established wild population of Pacific oysters in the estuaries of South Devon and Cornwall. Cook and Stebbing (2018) state that in such areas it is likely that the biomass of wild stocks significantly exceeds that of local cultured stocks, therefore the highest reproductive output is likely to be from wild rather than cultivated stocks. Cook and Stebbing (2018) conclude that for areas where significant wild populations are present, there is little benefit from restricting aquaculture activities.

Modelling of larval dispersion and settlement risk supports this, demonstrating that spawning from wild Pacific oysters leads to dispersal of larvae (including those capable of settlement) throughout the southern coast including South Devon (Wood *et al.*, 2021; attached). Indeed, areas of South Devon including around the mouth of the Dart and Devon Avon were identified as moderate to high risk of settlement from wild populations (Wood *et al.*, 2021). Settlement from aquaculture populations was identified as likely having been overestimated since the study did not account for the use of triploid Pacific oysters in aquaculture activities (Wood *et al.*, 2021) (see below for more on triploidy). Although the authors of Wood *et al.* (2021) focus their discussion on national-level policy implications and are cautious about site-specific application of the results, they also state that their data on unaided dispersal suggest that "*restricting further aquaculture and undertaking management of wild M. gigas populations on the south coast of England is unlikely to reduce its long-term distribution dramatically*" (Wood *et al.*, 2021).

Lallias *et al.* (2015) assessed Pacific oyster genetics and identified that Pacific oyster populations in South West England and South Wales were not comprised entirely of stock from UK hatcheries, as had previously been assumed. Populations in the South West, including in Devon were identified as clustering genetically with population from northern Brittany. Lallias *et al.* (2015) highlighted that "possible explanations include natural dispersal from North Brittany, importation of seed from natural recruitment from France for cultivation purposes, unintentional introduction by hull fouling or release of larvae from ship ballast water." However, the authors did not have evidence to support one hypothesis over another. Although the work of Wood *et al.* (2021) suggests that Pacific oyster introduction to Devon from northern Brittany is unlikely to have occurred from a single spawning event, successive spawning events using colonised artificial structures as "stepping stones" are a plausible

introduction pathway, as are routes such as fouling of ballast water, particularly around busy ports (e.g. the nearby port of Plymouth).

Other estimates of natural larval dispersal distance vary widely, largely based on local/regional water movement patterns. Based on simulations, Robins *et al.* (2017) suggested maximum dispersal distances exceeding 160 km, with a proportion of larvae from south Wales capable of reaching Ireland. These were the maximum distances identified by Robins *et al.* (2017), who also calculated *average* dispersal occurring over approximately 39 km if larval behaviour uses tidal patterns to assist dispersal, or 25 km if they simply drift with the prevailing current. Dispersal can occur over larger distances and in shorter timeframes with the assistance of, for example, shipping activity that unintentionally transports this species in ballast water or on fouled structures.

Overall, evidence demonstrates that the establishment and growth of wild Pacific oyster populations along the south coast of the UK are highly unlikely to be limited by larval supply, which would be saturated from spawning wild populations, and that aquaculture sites are likely to have minimal contribution to spread of wild populations: especially given the use of triploid stock where possible.

The risk of triploid stock becoming able to spawn is very small; where this occurs it is typically because a small number of egg- and sperm-producing cells in the oyster gonad revert to diploid, making the individual a diploid/triploid mosaic. However, mosaic individuals typically have very low numbers of diploid cells, which have low fecundity and reproductive potential. These issues are summarised in Smyth *et al.* (2022) (attached, in particular from page 28 onwards). Smyth *et al.* (2022) also outline the evidence demonstrating that triploid-triploid and triploid-diploid crosses have very low reproductive potential and survival of larvae to settlement stage. The estimates presented by Smyth *et al.* (2022) are also likely to represent a maximum range as the study was undertaken in a laboratory, and reproductive success in the wild will be further limited by density and proximity of other spawning individuals, as well as by local hydrodynamics. Therefore, the presence of Pacific Oysters in the Dart and Avon aquaculture sites is highly unlikely to have any bearing on the future development of wild Pacific oysters in the region.

In summary, the only potential effect of the farming of Pacific oysters would be to contribute larvae from spawning of the reared stock, however the evidence indicates that larval supply is plentiful from wild populations and therefore is unlikely to be the limiting factor in wild population growth. The continued aquaculture activity is therefore considered to have no bearing on the viability or spread of the species in the region. The impact on the spread of Pacific oyster from aquaculture sites in the Dart and Devon Avon Estuaries is not predicted to have significant effects on the achievement of the conservation objectives of the Dart or Devon Avon Estuary MCZs, and no significant adverse effect on the integrity of the nearby Start Point to Plymouth Sound and Eddystone SAC. The recent HRA conducted by FHI for Pacific oyster aquaculture in the Devon Avon made the same conclusion, which has been supported by Natural England (see attached HRA) (FHI, 2023). D&S IFCA is aware that Cefas FHI is in the process of conducting a review of assessments for Pacific oyster aquaculture activities within or near to European Marine Sites. The attached HRA is part of that review. D&S IFCA is also aware that another HRA has been completed for Pacific oyster aquaculture activities occurring in Essex estuaries; this HRA also concluded beyond reasonable scientific doubt that the assessed activities would not have an adverse effect on the integrity of assessed sites, either alone or in-combination with other plans or projects.

Control of Pacific Oyster

Whilst recent modelling conducted by Cefas (Teixeira Alves *et al.*, 2021) demonstrates that removal of Pacific oysters from a wild population could reduce the population density, the long-term effectiveness of removal will be impacted by level of removal and frequency of internal and external recruitment events: the higher the spawning frequency and the higher the level of external recruitment, the greater the control effort required to deliver a reduction in population (Teixeira Alves *et al.*, 2021).

Teixeira Alves *et al.* (2021) showed that control measures are unlikely to be 100% effective in removing all individuals of a wild population, do not offer a means of widespread eradication and need to be ongoing to maintain effectiveness. Their modelling demonstrates that even under a medium scenario of external recruitment (likely to be exceeded given extensive populations along the south coast) and *no local spawning*, eradication control would have to remove more than 50% of the population every year in order to have a chance of eradication within 5 years (Teixeira Alves *et al.*, 2021). External recruitment to areas such as the Dart and Devon Avon, from wild populations along the south coast, is likely to be high. Teixeira Alves *et al.* (2021) showed that while the density of populations subject to high levels of external larval recruitment can be reduced markedly through management, a reduction of 90% of the initial density can never be achieved, irrespective of the initial density, spawning frequency and management effort/frequency combination.

This needs to be understood in the context of the Natural England study on monitoring and eradication of Pacific oysters in the South West. This study demonstrated that volunteer ability to control Pacific oysters in the Dart was very low: Out of over 176,000 oyster culled in the South West between 2017–2020, fewer than 600 of these were from the Dart. By comparison, over 85,000 were removed from the Fal, 3,700 from Plymouth Sound and Estuaries SAC and over 5,000 from Salcombe-Kingsbridge Estuary. This appears to reflect the difficulty experienced in recruiting volunteers to work on the Dart. That being said, depending on the conditions of the lease, mariculturists could have a role to play in population control by harvesting some wild stock where possible. This is therefore an important consideration when determining whether leases will be granted or extended. Without the presence of mariculturists harvesting, maintaining and monitoring sites the ability for the removal of wild stocks in the vicinity will be severely limited.

Many other reports have highlighted the challenges of controlling Pacific oyster spread in the UK and Europe. For example, King *et al.* (2021) states that management efforts are "*likely to be undermined by the widespread nature of large source populations and C. gigas's extensive dispersal capacity*", and that as management interventions "*are unlikely to prevent expansions, there may need to be a change in attitudes of managing C. gigas, away from that of traditional [Invasive Non-Native Species]*". King *et al.* (2021) also note that "*In some countries (e.g. the Netherlands), acceptance of* C. gigas *as a "naturalized" species occurred decades ago, and there is increasing discussion on managing* C. gigas *expansion as a natural resource in countries where expansions have occurred more recently*". They state that the perception of Pacific oyster as positive or negative will depend both on the priorities of ecosystem managers and on the potential impacts to vulnerable sites (e.g. the MPAs discussed above) (King *et al.*, 2021).

Introduction of Microbial Pathogens

There are no significant adverse effects predicted from the introduction of microbial pathogens as all Aquaculture Production Businesses operate to a biosecurity measures plan. For example, the Biosecurity Measures Plan for the Waddeton Order specifies a range of actions required to ensure stock health prior to import and during culture, and reporting requirements for movements, disease and mortalities. There have been recent updates to this plan and the system of logging shellfish movements with Cefas, both of which give D&S IFCA even greater oversight of operations.

Filtration & Wider Ecosystem Benefits of Pacific Oysters

Pacific oysters are known for their filter feeding capabilities and their role in maintaining water quality. A single adult oyster can filter more than 50 gallons of water per day. A study by National Center for Coastal Ocean Science (NCCOS) in the United States measured the amount of nutrients removed by oysters to develop nutrient management plan and demonstrated the removal of large quantities of nitrogen and phosphorus from the water. Ferreira *et al.* (2020) demonstrated the benefits of including aquaculture (oyster, mussels and clams) in watershed-scale nutrient management plans. Their study showed that bivalve shellfish not only provide direct economic benefits to a community but also provide ecosystem services including reductions of algal blooms and absorption of nutrients from the water.

King *et al.* (2021) highlighted the potential ecosystem benefits of Pacific oysters, including restoring benthic assemblages and ecosystem functions, particularly in areas where overfishing and disease have decimated populations of blue mussel (*Mytilus spp.)* and native oyster (*Ostrea edulis*), or where these cool-water species are threatened by climate change. King *et al.* (2021) discuss how, "*where they coexist*, *O. edulis generally occupies the subtidal and C. gigas the intertidal but they harbour similar epifaunal assemblages and can provide similar regulating services*". As highlighted above, they state that the perception of Pacific oyster as positive or negative will depend both on the priorities of ecosystem managers and on the potential impacts to vulnerable sites (e.g. the MPAs discussed above) (King *et al.*, 2021).

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