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A reappraisal of the history and economics of the Pacific oyster in Britain☆,☆☆

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ABSTRACT

The Pacific oyster (*Crassostrea gigas*) was introduced into British waters to support an industry suffering from the decline of the native oyster. Until recently significant conservation risk was thought to be negligible as British coastal waters were considered incompatible with the establishment of self sustaining populations. Those circumstances have changed. On warming southern coasts the Pacific oyster has naturalised and now occupies an intersection between two policy imperatives: one concerning the conservation of protected habitats, the other relating to livelihoods and the economics of coastal communities. This combined with inconsistencies of attitude and policy between immediate European Union neighbours has made the future management of the Pacific oyster contentious. In this context policy is influenced not just by scientific evidence but also by perceptions of the history and economics of the species in each member state. However whereas the conservation risk is increasingly well documented, the history and economics of the species are not. To balance the policy equation we reappraise the commercial history of the species in Britain and provide a first estimate of the full value to the British economy of British reared Pacific oysters, employing a novel approach to the economics of a single aquaculture species. The established view on the history of *C. gigas* in Britain has it introduced for aquaculture in 1965. Informed by formal taxonomic recognition of its synonymic relation with the Portuguese oyster, along with a search of primary sources, we provide a revised history with the first reliably documented introduction 75 years earlier, in 1890. The economic significance of the species, when conventionally reported as "value at first sale", is also underestimated. The full economic significance of a species is better represented by Gross Output and Gross Value Added through all stages of the value chain, but few if any estimates of these have been attempted for a single species. On the basis of an analysis of the 2011/12 market for British reared *C. gigas* from production to ultimate consumption, we estimate annual Gross Output to be over £13 million (more than five times the value at first sale), and GVA to be over £10 million. On the basis of the world market and comparisons with neighbouring state production, it is argued that British Pacific oyster production could be significantly increased once uncertainty over its management is resolved.

1. Introduction

The Pacific oyster (*Crassostrea gigas*) was introduced into British waters to support an industry suffering from the commercial decline of the native oyster *Ostrea edulis*. Until recently significant conservation risk from *C. gigas* was thought to be negligible as, although sufficient for the fattening of introduced seed, cool British coastal waters were considered incompatible with the establishment of self sustaining populations. Those circumstances have now changed. On warming southern coasts the Pacific oyster has naturalised (Herbert et al., 2012) and the species therefore occupies an intersection between two policy imperatives: one concerning the conservation of protected habitats, the other relating to livelihoods and the socio-economics of coastal communities. This makes questions on the future management of the Pacific oyster in Britain contentious. Adding to these basic tensions is a European Union legislative framework which provides sufficient flexibility (in terms for example of risk assessment and the categorisation of non-indigenous species) for member states to develop inconsistencies of approach. (Herbert et al., 2012 review the relevant Directives and legislative issues.) Contention around policy on the Pacific oyster makes the issue political, and in this context differing attitudes between immediate

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☆☆ Note on currency: Prices quoted are in GB pounds (£1 = 100p). Prices relate to the winter of 2011/12. On 1st January 2012, GB£1.00 = US$1.55 (US$1.00 = GB£0.55p).

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neighbours (such as the UK and France) are driven not just by scientific evidence but also perceptions informed by the history and economics of the species in each member state (Syvret et al., 2008). However whereas the conservation risk of the species is increasingly well understood, the history and economic significance of the species in Britain is not. This paper contributes to a balancing of the equation by providing a revised history of the commercial exploitation of the species in Britain and a first estimate of the full economic value of British reared Pacific oysters (as opposed to just value at first sale), involving a novel approach to estimating Gross Output and Gross Value Added (GVA) for a single commercial species.

2. The British oyster tradition

The commercial exploitation of oysters in Britain has a history at least as ancient as the Roman occupation (Winder, 1992). During the mediaeval period the value of native flat oyster (*O. edulis*) grounds were such that, in 12th century Essex, fishing rights were protected by Royal Charter and by the 16th century various forms of fishery regulation are known to have applied to Whitstable dredging operations (Yonge, 1960). By 1683, landings on Essex grounds were limited to "1000 barrels" per week (Laver, 1916).

Probably commencing in the 1830s, a boom in British oyster production was attributed by Mayhew (1851) to the provision of rapid transport via a growing railway system. However it also coincided with population growth, poverty and the consequent availability of labour (Neild, 1995). Official oyster landings were first recorded in 1886 with production of 40 million oysters reported for that year (Neild, 1995 also reported by Spencer, 2002 as around 3500 tonnes). However these figures are almost certainly a significant underestimate of total landings and, in any event, do not represent peak landings, as a precipitous fall in production between the 1860s and the 1890s is known to have occurred. Unreliable figures reviewed by Neild (1995) include an estimate (by Mayhew, 1851) of 500 million oysters passing through London's Billingsgate Market in 1850 and a total British annual consumption of 1.5 billion oysters reported by the *Times* newspaper as late as 1867 (The Times 15th October 1867).

While figures for the 19th century British oyster boom are unreliable, the fact remains that mid-century Britain was thought to contain the richest natural oyster beds in Europe: A resource which, along with deeper off-shore beds, generated much socio-economic benefit, as is indicated by various contemporary sources reporting hundreds of oyster boats and thousands of oystermen in each of a number of traditional oyster centres (see Neild, 1995).

The heyday of British oyster fisheries was followed by a "catastrophic fall" (Yonge, 1960). A Royal Commission on Sea Fisheries, reporting a decline as early as 1866, rejected over-fishing as an explanation. However 10 years later the problem was such that Parliament established a Select Committee specifically to inquire into the continuing scarcity of oysters. This body rejected the opinion of the Royal Commission, finding the principal cause of the decline to be over dredging. Modern authors also consider this to be the main cause of the initial (i.e. 19th century) decline (Neild, 1995; Yonge, 1960).

In any event, the dramatic decline in native oysters provided a strong economic rationale for the importation of seed oysters for fattening in UK estuaries. In addition to *O. edulis*, these imports included the non-indigenous American oyster *Crassostrea virginica* and the Portuguese oyster *Crassostrea angulata* which was considered a species distinct from *C. gigas*.

3. A revised history of *C. gigas* in Britain

3.1. Note on synonymy

As early as the 1960s, similarities of anatomy and habitat between *C. gigas* and *C. angulata* were taken to suggest that they may be the same species (Yonge, 1960). In the 1970s, on the basis of such evidence as indistinguishable larval and adult shells and ease of hybridization between the two (Buroker et al., 1979; Mathers et al., 1974; Menzel, 1974), it became increasingly plausible that *C. angulata* and *C. gigas* were the same species. More recent molecular genetic studies, summarized by Miossec et al. (2009), further indicated a very close genetic relationship between the two oysters (e.g. Biocca and Matta, 1982; Gaffney and Allen, 1993; Huvet et al., 2002) and subsequent nuclear and mitochondrial base sequencing have provided corroboration of this (Lopez-Flores et al., 2004; Reece et al., 2008). As a consequence of such work, the UK National Biodiversity network (whose members include both the pre-eminent taxonomic authority, the Natural History Museum, and the UK's statutory conservation agency) now regards *C. angulata* as a synonym of *C. gigas*. (*C. gigas* (Thunberg 1793), NBN ID code NBNSYS0000174740). Other recognised synonyms include the older binomial for the Portuguese oyster *Gryphaea angulata*.

This needs not however be taken to imply that the "Portuguese" and "Pacific" varieties are genetically or phenotypically identical and the extent of genetic differences has been taken to suggest that they may have initially diverged in east Asia a few hundred thousand years ago (Hedgecock et al., 2004). Nevertheless, in the context of a policy process grappling with tensions created by a number of potentially conflicting legal statutes, for reasons explained below, the formal recognition in Britain of *C. angulata* as a synonym of *C. gigas* is not insignificant.

3.2. Routes to Europe

In Europe the distinction between the Pacific and Portuguese oyster can be explained as the result of two distinct periods and routes of introduction. The first was during the 16th or 17th century, probably from Taiwan. It has been postulated that the Tagus estuary, Lisbon was the site of this first introduction from the Pacific (CIESM, 2003), possibly attached to the hulls of merchant ships (Spencer, 2002; Yonge, 1960). From this population (subsequently classified as *C. angulata*) stock was introduced into Britain as the "Portuguese Oyster" in 1926 (Utting and Spencer, 1992).

The second route involved the west coast of America, where populations of *C. gigas* from Japan (initially known as Japanese Oysters) were introduced into Washington State in 1902 (Loosanoff and Davis, 1963). These were subsequently regularly deposited as spat elsewhere on the US and Canadian Pacific coasts, gradually becoming sold as "Pacific oysters" by the trade (Ricketts and Calvin, 1962), possibly as a marketing response to Japan's involvement in WW2. In any event by 1947 naturalised populations existed in British Columbia, from which specimens were taken to the UK in 1964 (Walne, 1979) to replace diseased "Portuguese oyster" populations (Davidson, 1976).

The existence in Japan of three "races" of *C. gigas* with markedly different appearance has been interpreted as indicating high phenotypic plasticity and variation in appearance in response to both the nature of the seabed and the degree of crowding (Quayle, 1969). This combined with some genetic divergence in original Asian populations, founder effects (the limited gene pools of relatively small initial inoculums), and subsequent allopatric selection in distinct European and American environments suggests how distinct Portuguese and North American populations came to exist.

3.3. Revised estimate of first British introduction

Prior to the con-specific status now given to Portuguese and Pacific oysters, the first British introduction of *C. gigas* was considered to be in the mid-1960s (Spencer, 2002; Utting and Spencer, 1992). The same sources when re-interpreted in the context of that synonymy make the first introduction of *C. gigas* to be 1926, as a response to a further and sharp decline of British oyster fisheries earlier in that decade. However, in light of the known 19th century connections between UK and French oyster fishers (e.g. Neild,