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ECONOMICS AND MARKETING OF CANNED MUSSELS: 81-ABH-00099

Two species of mussels are common along the California coast. One, Mytilus californianus, the California mussel, occurs on exposed, hard intertidal and shallow subtidal substrates (see Figure 1). The other, Mytilus edulis, the bay mussel (also called edible mussel and European mussel) is believed to have been introduced accidentally to the Pacific on the bottoms of ships. It is common on hard substrate in bays and sheltered waters along the coast, but was formerly uncommon in exposed coastal areas.

Shortly after WWII, exploration for offshore oil and gas began in the Santa Barbara Channel and off Los Angeles, areas where previous subtidal oil and gas development had occurred (see Figure 2). (Subtidal oil and gas development off Santa Barbara has a history going back to 1896.) Several discoveries were made and several types of development structures were constructed to exploit these finds: piers, artificial islands and free-standing platforms. For reasons not fully understood, the fouling communities that developed on these structures, particularly on the platforms, included large numbers of M. edulis, here in an open ocean environment (see Figure 3).

Both species have similar life histories. Spawning apparently is triggered by a change in water temperature, usually in the spring and again in late summer, but spawning may be triggered at other times as well. The start of spawning by a few individuals appears to induce spawning in the other mussels in the vicinity, and most will release eggs and sperms in synchrony. Fertilization occurs in the water column, and the eggs develop and hatch into free-swimming planktonic larvae. After a short period of planktonic development the larvae are able, on encountering suitable substrate, to attach and change into the familiar shelled form.

There is a difference in growth for the two species with M. edulis growing faster. On new substrate, a newly-emplaced platform, for example, M. edulis initially dominates the fouling community. On older platforms, the slower growing M. californianus becomes more obvious, or dominant, and may attain large size (see Figure 4). Perhaps it is better able to withstand exposure to a high-energy environment. Whatever the reasons, newly-colonized platforms harbor M. edulis, the bay mussel, in quantity, whereas older platforms covered by older mussels tend to have more M. californianus.

Both species of mussel are edible. The bay mussel, however, has been much appreciated (and cultivated) in Europe and on the eastern seaboard where M. californianus is unknown. A market exists for the more familiar species, and would have to be developed for M. californianus.

Since the new oil platforms and old platforms from which the fouling growth has been removed offer a source of bay mussels off California, a supply of this species exists that was not available a few decades ago.

A typical development platform off California consists of several equipment decks on top of a supporting framework resting on the sea floor. The framework typically has four main legs reinforced with cross members, and numerous vertical oil conduit pipes, and the subsea portion offers a considerable area of hard substrate for the attachment of so-called fouling organisms (see Figure 5). Most of the growth is found on the upper 25 m (about 80 ft) of the structure (the platforms presently are emplaced in depths from 20 m [60 ft] to 265 m [about 850 ft.] and deeper emplacements are projected).

Growth on the support structures has been studied. Colonization is rapid with the dominant species apparently decided by the predominant planktonic species available for settlement at the time of emplacement. In most cases this has been M. edulis and a nearly pure culture of bay mussels may develop (see Figure 6). The bay mussel colony grows rapidly but after several years suffers inroads from other species including M. californianus, anemones, hydroids, barnacles, various mollusks, brittle stars, and sea stars, the last being predators on the mussels (see Figures 7 and 8). Eventually, an undisturbed platform fouling community closely resembles the fouling communities found on pilings along the open coast, and M. edulis becomes of minor importance.

If the fouling communities on the existing platforms were left undisturbed and were all that was available, there would be little potential for a fishery for bay mussels on these structures: The mussels would be too few and their shells too fouled with other animals to make harvest economically worthwhile. However, this is not the case. The older platforms, because of engineering concern over the stresses imposed by the bulk of fouling organisms, are cleaned from time to time by divers (see Figure 9), which permits recolonization by bay mussels (see Figure 10). Second, oil and gas exploration and development on the California OCS is continuing and new platforms are being emplaced.

At present, about 20 platforms are located off southern California and several more are planned for the near future. Studies of growth rates for M. edulis indicates the mussels reach harvestable size - 75 mm shell length (3 inches) - in one to two years. The rapid growth combined with an estimated carrying capacity of 50,000 kg (110,000 lbs) of mussels per platform suggest a potential fishery based on the existing and planned platforms in excess of 500,000 kgs. (more than one-million pounds) of bay mussels annually (assuming two years to maturity).

The market for mussels in California is developing. At one time it was demand limited owing to consumer antipathy for the product. In recent years, thanks in part to promotional education by Federal and State agencies, the market has increased and is supply limited, with most of the product (estimated 75,000 kg/year) being shipped in from

the northeast states. Local production is small (estimated less than 10,000 kg/yr) for reasons that will be discussed below.

The Project

Despite a growing market, the potential supply of mussels off California exceeds the present fresh market demand and will continue to do so for several years. Until demand catches up with supply, a need might exist for a preserved mussel product that would use the excess. Such a product would a) allow more efficient use of harvesters' vessels and time owing to greater market volume and b) offer a means for handling sporadic large-volume harvests such as might occur when a platform is cleaned. In the latter case, some mutual benefit between the oil companies and the harvesters might result in the form of a partial payment to the harvesters in return for cleaning the platform (an amount less than the current cost paid just to clean the platforms).

Several methods for preserving the mussels exist: drying, freezing, smoking and canning. Dry mussel meal has been used successfully as a poultry feed additive and the method of meal preparation is straightforward enough; however, the value of the final product has to be competitive with fishmeal and other protein products and necessarily requires a very low cost raw product. Mussel meal production in volume is not a cost-effective way to use the resource.

Freezing might be used to produce a high volume, high value product. One successful frozen mussel product presently marketed is a smoked, Cryo-Vac mussel imported from New Zealand. The product is

excellent; however, the market is a specialty market that does not appear capable of absorbing large quantities of mussels. Smoking *per se* (and pickling) also seem incapable of handling large volumes of mussels on an intermittent basis; canning, on the other hand, does.

Canned mussels are available as gourmet items in many food stores. These are usually lightly smoked and canned in a spiced sauce. Like other specialty items, the market for these products is limited.

During WWII, mussels were canned on the East Coast in quantity, chiefly in Maine. Following the war the case pack dropped, to about 50,000 cases in 1945 and to zero soon after because of a loss of market interest, depletion of the resource, or both. This product was reportedly packed in its own broth and was of excellent quality.

Universal Packers Corp., a small cannery located in Oxnard, California, was approached to see if they would be interested in trying some experimental mussel canning. They were. Since the cannery packs mackeral and squid as well as vegetables, no special problems were anticipated. This project was developed to pack about 100 cases (15 oz tall cans, 48/case) of mussels to determine the costs involved and the marketability of the product.

Institutional Problems

Mussels harvested for sale for human consumption are covered by Federal/State laws on shellfish sanitation, one of which requires the mussels be harvested from waters certified for shellfish culture. Since most of the platforms are well offshore and therefore remote from

potential sources of pollution, certification should be possible. Indeed, one Santa Barbara-based company engaged in mussel harvesting has obtained certification for an area of water offshore that city. However, certification requires the monitoring of the proposed water for coliform bacteria for up to one year and was not a practical approach for this project. Further, oil platforms discharge small quantities of treated sewage and, to date, none of the waters surrounding a platform has received certification. Instead, the company mentioned above harvests mussels from the platforms and relays them to rafts moored in the certified waters, where they are held for depuration for 30 days prior to sale to the fresh market, an economically unattractive process.

The State Health Services recognizes the problem and is working with interested parties to certify the waters at certain platforms, obviating the need to relay. However, for the purpose of obtaining sufficient mussels for the canning experiment, there was not enough time to resolve the certification problem. Further, relaying and holding for 30 days for depurating several tons of mussels was impractical. Instead, State Health Services agreed to permit a one-time harvest of sufficient mussels to run the experiment, provided they were tested for coliform bacteria prior to canning. Unfortunately, the oil companies insisted on requiring a 30 day depuration. This requirement made the project impossible as originally planned and it was terminated.

A second problem is paralytic shellfish poison (PSP). Certain species of dinoflagellates (protozoans) contain a toxin that, when large numbers of the organism are eaten by a mussel, is concentrated by the mussel in its tissue. Although the toxin does not affect the mussel, it may poison a person eating the mussel. Since the toxin is not destroyed by heat, mussels and other filter feeding shellfish likely to be exposed to the dinoflagellates in the food supply are quarantined.

A blanket quarantine on mussels and clams taken for human consumption in California is imposed by State Health from May to November. However, monitoring mussels for the toxin has shown it unlikely to be of concern off southern California. State Health, therefore, will permit the commercial harvest of mussels in that area during the quarantine period provided each batch is checked for the PSP toxin.

The third problem is obtaining permission from a platform operator to take mussels for the canning experiment. This was arranged with an operator subject to two conditions: State Health Services approved and proper insurance for the harvesting vessel and personnel. As was mentioned above, the former condition could not be satisfied in a timely fashion.

The final problem is the canning process itself. This, because of the experimental nature of the project, was really two problems. One was the development of a suitable canning process acceptable to State Health Services. A thermal process had to be found that gave an

acceptable product (texture, flavor and appearance) and also heated the product to a temperature sufficient to kill potential botulism-causing agents. The second part of this problem involved working out a schedule whereby the cannery schedule would not be interrupted by the experimental work.

Results

The goals of this project were:

A. Develop an acceptable canned mussel pack in terms of texture, taste, appearance and wholesomeness.

B. Determine the commercial feasibility for the product.

A. The Process. The anticipated product was to be mussel meats packed in brine or broth in the standard one-pound tall can. Several trials were made resulting in a State Health Services-approved thermal process. Mussels for the initial trials were obtained from uncertified waters (see Figures 11 and 12) and the pack discarded after the cans were sealed. These trials were to work out the logistics of opening, cleaning and packing the mussels in the cans. Later trials used mussels purchased from the depuration rafts off Santa Barbara and were run to develop the final pack.

The final process as approved is:

Fresh mussels are cleaned with a high-pressure spray. This is sufficient to clean mussels taken from new growth. Older growth mussels have shells heavily fouled with barnacles, anemones and other organisms and could be cleaned only by laborious scrubbing. The latter are not felt suitable for packing in their own broth.

Next, the mussels are inspected and dead or partially open ones discarded. The mussels are then steamed open in a retort - about 10 minutes. The broth, if it is to be saved, is strained and collected. (Another method of opening we considered but did not employ was to pass the mussels through the cannery steam box on the conveyer. Such a continuous process might make both the pre-steaming inspection and the subsequent shucking more efficient.)

The opened mussels are shucked by hand and the byssus (threads that attach the mussel to the substrate) removed. The meats are packed by hand into the cans until the desired fill weight of 200 grams (7 ounces) is achieved. The cans are filled with spring water and 30 grams of salt added; or with broth and 3.5 grams of salt added. The filled cans were exhausted 20 minutes in the steam box (see Figure 13) bringing the temperature to about 70°C (160°F) (see Figure 14), sealed and retorted for 24 minutes at 116°C (240°F) (see Figure 15). Two other retorting times and temperatures also were approved: 55 minutes at 110°C (230°F) and 13 minutes at 121°C (250°F). The former yields a poorly-textured product; the latter was not attempted but should yield a good quality product owing to the short cooking time. A summary of this approved process is given in Table 1.

Table 1

Process for Canned Mussels

Step	Procedure
1. Cleaning	Mussels are washed with high-pressure cold water.
2. Sorting	Mussels are inspected and dead or partially open mussels discarded.
3. Cooking	Mussels are steamed open (10 minutes). Broth may be collected and strained.
4. Shucking	Meats are shaken or picked from shell and byssus removed.
5. Packing	200 gms (7 oz) meats are packed into 15 oz tall cans. Cans are filled with broth and 3.5 gms salt added, or with water and 30 gms salt added. Total weight contents 425 gms.
6. Sealing	Cans are steam exhausted 20 minutes, bringing temperature to about 70°C (160°F), lids applied and cans sealed.
7. Retorting	Cans are retorted for 24 minutes at 116°C (240°F) and allowed to cool.

Mussels packed in this manner have a good appearance, texture and flavor (see Figure 16). Since they are collected offshore in deep water, they are free from mud, sand and grit. Owing to the premature termination of this project, taste panel testing and test marketing of the product were not accomplished. However, judging from the sample pack, this product will be excellent for soups, chowders, salads and sauces.

B. Commercial Feasibility. For this project commercial feasibility is taken to apply only to the harvesting segment of the industry. We assumed the final product would compete with similar canned products -- clams, oysters, ear-shells, marine snails -- and would retail between one- and two-dollars per can. We then assigned various levels of profits and costs to the sellers and the cannery and an observed yield factor to estimate ex-vessel price. Shucking and packing labor cost was felt to be potentially a significant factor and was examined separately.

Yield. Yield is defined as the weight percent cooked meats to whole (live, shell on) weight. In a series of trials, yield varied from 10% for small mussels from a heavily fouled platform to 40% for large mussels from a recently-cleaned platform. the main difference in yield was due to shell weight: The slower growing mussels from a heavily fouled platform having thick shells. Yield also varied with condition factor, recently-spawned mussels having a poorer yield. Under average conditions and using mussels from continuously harvested platforms, yields of 20% to 30% should be obtainable.

Shucking. Shucking mussels, removing the byssus and packing the meats, is time consuming. With little or no practice a shucker could process 30 to 50 kgm (65 to 110 lbs) of cooked mussels per hour. Since this performance is at the bottom of the learning curve, production of 100 kg (220 lbs) per hour should be readily achievable. Assuming a yield of 20% and a wage of $3.90/hr, the total labor cost (shucking and packing only) would be:

Table 2

Per Can Labor Costs (at $3.90/hr) at Two Efficiencies and Three Yield Values

Yield	Production kg/hr	
	50 kg	100 kg
20%	$0.0780	$0.0390
30%	$0.0520	$0.0260
40%	$0.0390	$0.0196

The cost for shucking and hand packing evidently may be worth minimizing but is not, in itself, a major factor in product cost.

Raw Product Cost. Table 3 explores the potential ex-vessel price for mussels under different assumptions of profit and cost.

Table 3

Ex-vessel Price Derived from Assumed Product Costs and Profits

		Cost Per Can		
Retail price/can		$1.00	$1.50	$2.00
Less				
Retail mark-up (5%)		.95	1.425	1.90
Jobber & Wholesaler (30%)		.714	1.071	1.429
Cannery cost/can	$0.20	.514*	.871*	1.229*
	$0.30	.414*	.771*	1.129*
	$0.40	.314*	.671*	1.029*

*Under the assumptions above, these figures represent potential ex-vessel price per kg if each can holds 200 gms meats & the yield is 20%.

Over the range of selling prices and costs used in the table, the ex-vessel price may range from $0.31 to $1.23 per kilogram or from about $0.14 to $0.56 per pound. The lower price does not seem sufficient to support a viable fishery. In fact, none of the prices available in the $1.00/can retail column are likely sufficient for this purpose. At retail prices in the $1.50/can to $2.00/can range, however, the potential ex-vessel price ($0.30 to $0.56/lb) compare favorably with sea urchins, another diver-harvested resource and a fishery for a cannery market appears feasible.

Conclusions and Recommendations

1. There is a resource of mussels Mytilis edulis on the oil and gas development and production platforms on the southern California OCS south of Morro Bay.
2. The present market for mussels is limited owing to health regulations and problems penetrating the existing market, which presently relies on out-of-state mussels.
3. Until the waters surrounding each platform are certified as shellfish growing waters, mussels taken from the platforms must be relayed to approved depuration sites and held for 30 days.
4. Because of the depuration requirement in 3. above, it is not economic to harvest mussels from the platforms.
5. If the waters around each platform are certified, a mussel fishery is likely with ex-vessel prices ranging from $0.60 to $1.00/kg, and even higher prices for the fresh market.

6. The fresh market is expected to be minor for the foreseeable future owing to competition from imports and consumer acceptance; however, the full potential of the resource might be realized if a fresh market were complemented by a cannery market, which would absorb a larger volume of mussels but at a lower ex-vessel cost.
7. The cannery market would be especially valuable for absorbing large volumes of poor quality mussels such as would be produced when first harvesting a platform.
8. This project has resulted in the development of an approved thermal process for mussels.
9. The major obstacle impeding the development of this fishery is the failure, so far, by the oil and gas industry to obtain certification for waters surrounding the platforms. Several companies are presently actively pursuing certification, and one recently has obtained certification for one platform.

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