California Fish and Game 96(2): 129-145; 2010

COST OF VESSEL INSURANCE IN COLLABORATIVE FISHERIES RESEARCH: STRATEGIES AND PERSPECTIVES FROM A PROGRAM IN CALIFORNIA, USA

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Collaborative fisheries research (CFR) is an emerging alternative to traditionally centralized approaches to resource management, and it is considered attractive because of the social and scientific benefits of including stakeholders in research. Although CFR now has institutional support and precedent in California, it is often impeded by the cost and difficulty of procuring vessel insurance for commercial vessels. This report summarizes important financial and logistical considerations from our experience procuring vessel insurance as University of California (UC) researchers building a collaborative fishery research program with commercial fishermen and oversight from the California Department of Fish and Game. Current UC policies require that charter vessels carry $1 million in Protection and Indemnity (P&I) coverage, and in our research program this cost an average of $4889 annually per commercial lobster vessel (n=5). This level of insurance is typical of other universities, non-governmental organizations, and management agencies. Participation of multiple commercial fishing vessels benefits CFR programs by providing logistical flexibility, increasing sampling efficiency, and maximizing community participation. High total insurance costs, however, reduce direct funds for research. We present strategies for minimizing insurance costs in programs that employ multiple vessels. Alternatives to multiple vessel use are the dedication of a single (and insured) commercial vessel whose activity can be directed by additional onboard fishermen, as well as retrofitted research boats that can be used as fishing vessels that are captained by fishermen or researchers trained to use fishing gear by master fishermen collaborators. We explore the costs and benefits of these different strategies and we present additional recommendations for managing the cost of vessel insurance while maintaining the benefits of stakeholder participation in CFR.

Key words: collaborative fisheries research, commercial fishing, insurance, research, stakeholders

INTRODUCTION

Fisheries research is traditionally a centralized process in which government or academic scientists work independently of other stakeholders (McGoodwin 1990). An emerging alternative to this approach is cooperative fisheries research (CFR), a process that involves two or more stakeholders (e.g., scientists, commercial fishermen, recreational fishermen, non-governmental organizations [NGOs]) in at least some aspect of research. Cooperative fisheries research (CFR) that involves stakeholders during all phases of research (including hypothesis generation, data collection, and interpretation of results) is typically defined as collaborative research (National Research Council 2004). This distinction has important implications for program structure as well as the roles and expectations of participants. However, cooperative and collaborative fisheries research both have broad potential to improve fishery management by increasing the quantity and quality of data collected (Karp et al. 2001, National Research Council 2004) and improving communication, understanding, and trust between managers and stakeholders (McCay and Jentoft 1996, Conway and Pomeroy 2006).

In California, a series of recent events signals a new commitment to CFR. In 2007, the state legislature passed Assembly Bill 1280, which calls for increased funding and support for stakeholder involvement in fisheries management. In April 2008, the California Ocean Protection Council (OPC) sponsored a two-day CFR workshop attended by fishermen, scientists, and agency staff (Concur 2008). A major result from this meeting was the conceptual design of a CFR institute to support community-based research and invite research proposals generated by fishing communities seeking funds for CFR (California Ocean Protection Council 2008).

In addition to newly-developed institutional support for CFR, several ongoing cooperative projects demonstrate the feasibility and effectiveness of this approach. Perhaps the longest-standing cooperative interaction is the NOAA Fisheries groundfish observer program (Harms and Silva 2000, National Research Council 2004). Pomeroy and Beck (1999) reported on a cooperative data-sharing agreement between fishermen and a reserve manager in central California. More recently, several innovative CFR projects have organized around fisheries for sea urchin (Prince and Hilborn 2003, Schroeter et al. 2009), abalone (CDFG 2006), nearshore fish (Caselle et al. 2003, Wendt and Starr 2009, Starr et al. 2010, Wilson et al. 2010), and spiny lobster (Kay et al. 2008). There is clear precedent and increasing institutional support for CFR in California.

Broad implementation of CFR is limited by a number of barriers. Foremost among these are vessel insurance requirements for chartered vessels (Nixon and Dieter 1989, California Ocean Protective Council 2008). Typically, universities, resource agencies, and NGOs require that a charter vessel (any vessel receiving payment to perform any task at-sea) carry coverage for hull and machinery (H&M) as well as $1 million for Protection and Indemnity (P&I). Commercial vessels often carry H&M coverage but seldom carry P&I, so the latter (or both) is typically paid directly from research grants. P&I can be prohibitively expensive for budgets associated with most fishery-related research grants ($10,000 - $100,000 per year) and is often difficult to procure. The severity of this issue is reflected by the fact that California's CFR institute is structured to include a staff position for researching solutions to vessel insurance issues (California Ocean Protection Council 2008).

The administrative partner (i.e., the entity that receives and administers research funds) in CFR can be exposed to liability because CFR imposes risks that are typically not factored into the administrative institution's general insurance policies. For example, the University of California (the administrative partner in our collaboration) maintains a general liability self-insurance policy that covers employees injured while acting in the "course and scope" of their job descriptions, and provides liability coverage for operations undertaken on UC vessels under 30 feet in length (with a limit of $5 million, coverage from $5 - $75 million is provided through an additional UC Marine Insurance Policy). Because the UC general liability self-insurance program explicitly does not cover injuries to non-UC personnel or damages and injury caused by non-UC owned vessels, any UC-sponsored charter of such vessels is viewed by the University of California Office of the President (UCOP) as liability exposure. Consequently, UCOP and the UC Office of Risk Management require that charter vessels provide the following P&I policies: 1 - 10 passengers, $5 million; 11 - 22 passengers, $10 million; >22 passengers, $15 million.

Charter vessel P&I requirements across the UC system were increased from $1 million to $5 million (for 1 - 10 passengers) in 2005 when UC changed insurance brokers and the incoming company performed an industry audit and update of coverage levels. The $1 million P&I requirement for vessels in our CFR program is an exception to the current $5 million baseline requirement explained above, and is a return to requirements in place from 1986-2005. This reduction was implemented as a result of a joint UCOP and UC Risk Management realization that: (1) the $5 million requirement would be prohibitive to research; and, (2) our research is typically conducted by very few, but experienced, individuals that are risk moderate.

This study examines important logistical and financial considerations generated from our experience coordinating commercial fishing vessels and procuring vessel insurance for our UC-based collaborative fishery research program (CALobster: www.calobster.org). We place specific emphasis on basic costs and the potential impacts of a P&I requirement of $5 million (currently $1 million for single UC researchers aboard commercial vessels), and we present strategies for minimizing insurance costs while ensuring participation from multiple fishermen. Although our focus is on CFR in California, the research bottlenecks we encountered with vessel insurance are shared by CFR programs nationwide. Our objective is to inform new CFR policy makers, who can then contribute solutions to this challenge.

MATERIALS AND METHODS

Policy Costs

To compare the costs of different insurance policy (i.e., coverage) options, we obtained insurance estimates for five commercial lobster vessels involved in ongoing collaborative research at the Santa Barbara Channel Islands. We obtained price quotes for five policy types for each vessel: (1) H&M coverage; (2) H&M with $1 million P&I coverage; (3) H&M with $5 million P&I; and (4-5) $1- and $5 million P&I policies for vessels with pre-existing H&M coverage. H&M is not a legal requirement for commercial fishing vessels, but was required by insurance providers as a base policy for any P&I coverage for all vessels in this study. We then calculated an average cost for each type of policy based on these estimates. Means for each type were compared with one-way analysis of variance (ANOVA) followed by a Student-Newman-Keuls test (alpha = 0.05). Raw data violated assumptions of homogeneity of variance and were square-root transformed prior to ANOVA (Cochran's C = 0.3057 after transformation).

All policy estimates were acquired directly from vessel owners or from the insurance representatives for each vessel owner. In the latter cases, we communicated jointly with both parties to gain access to information while respecting the privacy of the vessel owners. In the interest of privacy, results for all vessels are reported here as means (i.e., mean cost of each policy from all five boats) and detailed descriptions of individual vessels are avoided.

Our sample size (n = 5 replicate vessels) is small, but viable because the vessels we examine in this study are representative of the broader fleet and the total number of active vessels in our region is also small. For example, in 2008-09 a total of 21 active lobster vessels (defined here as vessels landing at least 1000 pounds) used Santa Barbara Harbor as their primary landing site, and a total of 38 active vessels made landings at all ports in the Santa Barbara Channel (Santa Barbara Harbor, Ventura Harbor, and Channel Islands Harbor; K. Barsky, CDFG, personal communication). Thus, our sample size represents 23.8 and 13.2% of active vessels from Santa Barbara Harbor and the entire Santa Barbara Channel, respectively. Finally, competing underwriters typically calculate rates from standardized schedules and charge very similar rates for a given level of protection for a given vessel (e.g. no greater than 10% difference), and therefore this is not a significant source of unaccounted variance in our analysis.

Cost of Insuring Multiple Vessels

To describe the impact of policy cost on the number of vessels that could be insured on a medium-sized ($100,000/year) CFR grant, we used the per-vessel insurance costs calculated above for four policy types: (1) $1 Million P&I with H&M; (2) $1 Million P&I without H&M (existing H&M on vessel); (3) $5 Million P&I with H&M, and; (4) $5 Million P&I without H&M (existing H&M on vessel). For each policy type, we report the relationship between cost and the number of vessels insured. The amount of $100,000 was selected arbitrarily, but represents a typical total annual sum granted for CFR projects in our region.

Cost-Benefit of Hiring Single vs. Multiple Commercial Vessels and/or Fishermen and Use of a UC Vessel With Industry-Trained Staff

To determine how insurance costs influence the number of days of at-sea research that a grant can afford, we explored the trade-offs between insurance costs vs. research benefits (days at sea) associated with hiring a single commercial vessel, multiple commercial vessels, and use of a UC-owned vessel operated by fishery-trained UC staff. For each of the four policy types ($1- and $5 million P&I, with and without H&M), we projected the relationship between cost (initial and cumulative expenses in U.S. dollars) vs. benefit (reported as number of research days at sea) under four hypothetical, but realistic, scenarios: (1) one commercial boat is insured and an additional fisherman is hired to work on the insured vessel four days per field season; (2) two commercial boats are insured and an additional fisherman is hired to work on an insured vessel for two days during the field season; (3) three boats are insured and no additional fisherman-days are budgeted; and, (4) research is conducted primarily from a UC vessel operated by a UC biologist that was trained by the industry to sample with commercial fishing gear. In scenario 4, there is also a cost incurred when the UC biologist makes six trips per year on commercial vessels to receive training at different sites.

The cost/benefit model presented here calculates benefits as “research days at sea”, but the logistical benefits of hiring additional vessels and/or fishermen should be considered carefully. Financial costs were modeled as:

$$C = (B * P_c) + \sum_d C_d + (D_a * C_a) + (C_S) \qquad \text{Equation 1}$$

where: B = number of commercial boats insured (Table 1), P_c = cost of insurance policy (Table 2), C_d = charter cost/day of vessel(s), d = number of days, D_a = number of additional fisherman days, C_a = cost/day for additional fisherman, and C_s is the cost to install (in year 1) or maintain (years 2+) lobster trap-hauling machinery on a vessel owned by UC. The cost for additional fishermen in scenario 2 (two additional fisherman-days x \$1200/day = \$2400 total) was arbitrarily assessed at day 8, the cost for additional fishermen in scenario 1 (four additional fisherman-days x \$1200/day = \$4800 total) was arbitrarily assessed at days 8 and 16 (\$2400 each installment), and the cost for additional fishermen in scenario 4 (six additional fisherman-days x \$1200/day = \$7200 total) was assessed at days 1, 8, and 16.

Vessel Descriptions

Table 1. Parameter values used to project vessel costs (Equation 1) under 5 different scenarios. B = number of boats incurring externalized (outside UC) insurance cost; C_d = cost per vessel-day; D_a = number of additional fisherman-days; C_a = cost per D_a; and C_s = setup cost (scenario 4a for year 1) and maintenance cost (scenario 4b for year 2+) for commercial equipment refit on UC vessel (see text for details).

	B	C_d	D_a	C_a	C_s
Scenario 1	1	\$1200	4	\$1200	0
Scenario 2	2	\$1200	2	\$1200	0
Scenario 3	3	\$1200	0	\$1200	0
Scenario 4a	1	\$800	6	\$1200	\$6183
Scenario 4b	1	\$800	6	\$1200	\$750

Table 2. Mean cost of various coverage options for hull and machinery (H&M) and protection and indemnity (P&I) insurance.

Coverage	Mean cost
H&M	\$ 3525
H&M + \$1 million P&I	\$ 4889
H&M + \$5 million P&I	\$ 9919
\$1 million P&I (no H&M)	\$ 1308
\$5 million P&I (no H&M)	\$ 6394

Insurance costs for fishing vessels in CFR depend upon unique characteristics of individual vessels, especially their length, hull design, and electronics and machinery. Vessels in the spiny lobster fishery at the Santa Barbara Channel Islands range in length from ~7-13 meters, were constructed in different locations, and represent a broad array of hull designs and on-board machinery. The five boats described here reflect this fleet diversity and were selected to ensure that we obtained representative mean costs for insurance policies. Specifically, vessels were 7 - 13 m in length, were constructed either locally (Santa Barbara = 2, U.S. east coast = 2, Iceland = 1), and their assessed replacement values ranged from $45,000 to $200,000. Finally, the vessels addressed here are broadly representative of those used in many U.S. west coast nearshore commercial fisheries for lobster, rock crab, spot prawn, fish, live fish, sea cucumber, and sea urchin, and each of the vessels reported here is licensed to participate in at least two of these fisheries.

RESULTS

Insurance Policy Costs

Mean insurance costs varied significantly across policy types (1-way ANOVA, $F_{4,20} = 20.29$, $P < 0.0001$; Figure 1). The cost of Hull and Machinery coverage (H&M) and $1 million Protection and Indemnity (P&I) was $4,889 per year, an annual cost that doubled ($9,919) and thus significantly increased (SNK, $P < 0.05$) when the P&I coverage was increased to $5 million (Table 2). Similarly, a $1 million P&I policy added to existing H&M coverage cost $1,308, but the cost increased markedly and significantly (SNK, $P < 0.05$) to $6,394 with P&I coverage of $5 million. In contrast, the per-vessel mean costs did not vary significantly among the three policies offering H&M only, H&M with $1 million P&I, or $5 million P&I without H&M (SNK, $P > 0.05$; Figure 1).

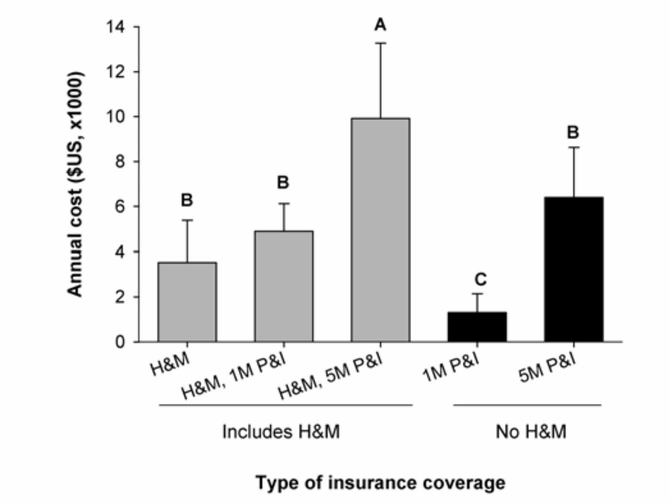

Figure 1. Mean cost of five different insurance coverage options. Note that Hull and Machinery (H&M) is a required base policy for any Protection and Indemnity (P&I), and so the cost of $1- and $5 million in P&I alone (black bars) is relevant only for vessels with preexisting H&M coverage. Means for each coverage category are means from five vessels, bars with the same letters (A, B or C) above indicate no statistical difference (SNK test, $P > 0.05$). Error bars are 95% confidence limits.

The average cost of adding $1 million P&I to existing H&M coverage was approximately four times cheaper than purchasing the entire policy (H&M and P&I). The mean cost of H&M with $1 million P&I was $4,889, whereas the addition of $1 million P&I to existing H&M coverage was significantly less expensive at a mean cost of $1,308 (SNK, $P < 0.05$). Finally, the mean cost of H&M with $5 million P&I was $9,919 whereas the addition of $5 million P&I to existing H&M coverage resulted in a less expensive mean cost of $6,394 (SNK, $P < 0.05$). The mean cost of H&M coverage for the four vessels was $3,525.

Cost of Insuring Multiple Vessels

The type of coverage policy (Table 2) and the number of vessels insured both had marked impact on the percentage of a 1-year, $100,000 award that was paid out as insurance (Figure 2). We suggest that such an award can support a maximum annual insurance burden of approximately $10,000. A P&I requirement of $5 million per vessel (including H&M) would consume 9.9% of the annual budget. In contrast, insurance for a single vessel under the current UC $1 million P&I requirement (including H&M) consumes 4.9% of the same annual budget. As additional vessels are insured, the $5 million P&I requirement quickly dominates expenditures, but the costs rise less steeply when $1 million P&I is applied (Figure 2). The purchase of $1 million P&I for existing H&M policies not only bears the lowest mean per-vessel cost, but also allows for multiple vessels to be involved in research while maintaining a relatively low total cost to the research award.

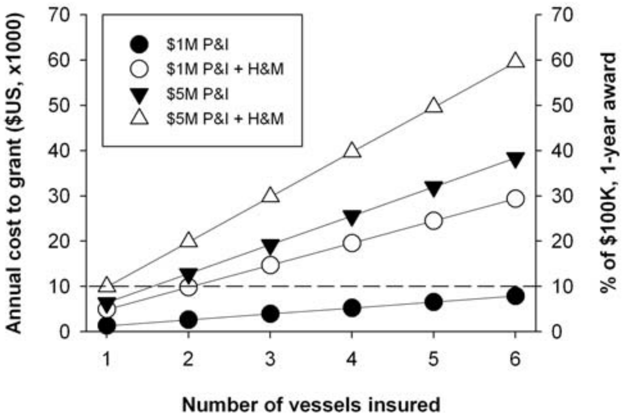

Figure 2. Annual cost of insuring 1-6 vessels under each of four policy types: $1 million P&I (H&M paid by fisherman), $1 million P&I + H&M, $5 million P&I (H&M paid by fisherman), $5 million P&I + H&M. The costs for a single vessel are the averages presented in Table 2 and Figure 1. Costs for multiple vessels are additive. Horizontal line represents arbitrary maximum amount ($10,000) that could be paid out from a total annual research budget of $100,000.

Cost and Benefit of Insuring Multiple Vessels or a UC Vessel

Cost projections for vessel scenarios in which one, two, or three commercial vessels are insured (and four, two, or zero additional fisherman-days are paid, respectively; Table 1) indicate that it is generally more affordable to insure fewer vessels and hire additional fishermen to work two - four days/field season as experts on the insured vessel(s) (Figure

3). However, when insurance expenses are limited to $1 million P&I with H&M provided by fisherman, the higher initial cost of insuring three vessels is eventually surpassed by the cost of hiring additional fishermen to work on the insured vessel (Figure 3A).

The high cost of insuring multiple vessels is clearly exacerbated by policies that require H&M in addition to $1million P&I or any policy with $5 million P&I (Figure 3). For such policies, a feasible scenario to include multiple fishermen in research is to insure a single (or two at most) vessel(s) and hire additional fishermen for 2-4 days/field season as consultants on that vessel. The inflections on “1 boat” and “2 boats” projections (Figure 3) are due to the arbitrarily-timed assessment of additional fisherman-days at days 8 and 16.

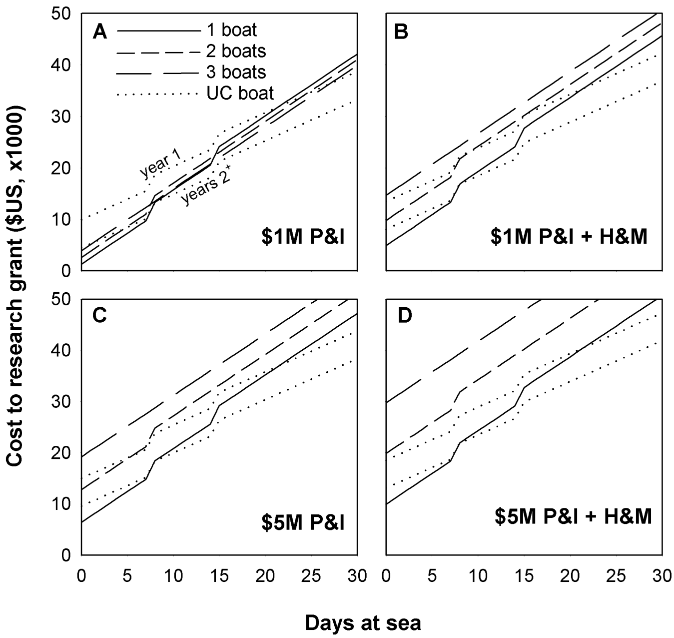

Figure 3. Cost projections for total days chartered (at $1200/day) when insuring 1-3 vessels under each of four different insurance policies (see text). The cost projections when a single vessel is insured (solid lines) include the assessment of two additional “day rates” of $1200/day at days 8 and 16 ($4800 total). The cost projections when two vessels are insured (short dashed lines) include the assessment of two additional “day rates” of $1200/day at day 8 ($2400 total). Points at which lines cross y-axes represent initial insurance costs.

Use of a UC vessel during our program was less expensive than working exclusively off of commercial vessels. This was especially true as the numbers of days at sea increased, and during years 2+. The latter savings was due to the cost of installing commercial trap-hauling machinery ($6183 in year 1) vs. maintenance costs for the machinery ($750 in years 2+). Two additional fisherman-days were assessed at days 1, 8 and 16, and cause the inflections at days 8 and 16. The logistical drawbacks of conducting CFR from a university or agency vessel rather than a commercial fishing vessel are severe and they should be considered carefully.

DISCUSSION

Vessel Insurance –The Challenge

Purchasing vessel insurance can be an unmanageable expense or process for research programs that place university, agency, or NGO personnel on chartered vessels. Funding for CFR is difficult to acquire, and grants are typically small and must cover a wide range of costs that are not typical of more traditional research projects. The additional cost of relatively expensive insurance policies is becoming increasingly untenable as funding opportunities are limited by a broader economic downturn. Although fisheries scientists are employed by various institutions, the UC insurance requirements used as a model in this study are typical of other universities, resource agencies, and NGOs (Nixon and Dieter 1989; L. Cobb, Port Orford Ocean Resources Team, personal communication 2009; T. Hartley, Northeast Consortium, personal communication 2009; M. Sanderson, Cape Cod Commercial Hook Fisherman's Association, personal communication 2009; Pacific States Marine Fisheries Commission 2009).

The cost of insurance is consistently identified as a primary challenge to CFR (Concur 2008), and it is not uncommon for insurance problems to delay research activities (M. Carr, U.C. Santa Cruz, personal communication 2009; J. Caselle, U.C. Santa Barbara, personal communication 2009; L. Cobb, Port Orford Ocean Resources Team, personal communication 2009; D. Wendt, San Luis Obispo Science and Ecosystem Alliance, California Collaborative Research Program, personal communication 2009). Such delays can frustrate CFR partners who must fit research into already tight schedules that are governed by fishing seasons and weather windows. In extreme cases, insurance issues have halted research where otherwise willing participants and funding were in place (M. Carr, U.C. Santa Cruz, personal communication 2009; L. Cobb, Port Orford Ocean Resources Team, personal communication 2009).

In cases where insurance acquisition does not delay research, high costs can still affect program structure by reducing the number of vessels able to participate (Figure 2). Although it is possible to conduct CFR from a single vessel, exclusion of other fishermen can limit important social benefits (e.g., McCay and Jentoft 1996, Conway and Pomeroy 2006), and weaken program stability. The latter is especially true when the primary vessel experiences mechanical problems, schedule conflicts arise, research involves multiple tasks or species for which alternative vessels are better suited, research encompasses vast areas that are not regularly visited by a single fisherman, research funds represent a significant source of income that could be more equitably distributed within fishing communities, or a single vessel owner feels isolated by collaborating with universities or fleet solidarity is compromised (Table 3). These issues are most acute for projects that cover large spatial and temporal scales, but may be trivial during short-term projects.

Logistical constraints of single commercial vessel	Logistical benefit of additional Commercial vessel(s)*	Logistical benefit of additional fishermen	Logistical benefit of additional Scientific vessel**
Missed research trips due to:			
Personnel schedule conflicts	+ + +	0	++
Fishing-related schedule conflicts	+ +	0	+++
Mechanical failure	+ + +	0	++
Primary vessel inappropriate for a certain task	+ + +	0	0
Primary vessel operator unfamiliar with all sampling sites	+ + +	+ + +	0
Fleet solidarity and support for project	+ + +	+ +	0
Uneven distribution of $ (research allocation)	+ + +	+	0

* The logistical benefits of multiple commercial vessels are countered by the high cost of vessel insurance, whereas insurance costs do not apply to additional fishermen (see text for details).
** Not appropriate for most CFR programs (see Discussion section for details).

Table 3. Logistical challenges to CFR when a single commercial vessel is used in larger-scale research programs, and the relative benefit (none [0], weak[+], moderate[+ +], strong[+ + +]) for resolving the challenges realized by involvement of additional commercial vessels/fishermen or scientific vessel(s).

Current Protection and Indemnity (P&I) requirements of $1 million can be supported, but with difficulty, by medium sized (~$100,000/year) and even smaller (e.g., $40,000-$60,000/year) grants. Of course, the cost of paying insurance reduces money available for research, and programs are likely to be restricted to single vessels despite the logistical disadvantages (Table 3). An increase to $5 million P&I will profoundly strain most research budgets (Figures 1 - 3) and might cause UC researchers to administer CFR budgets off campus, involve fewer vessels in CFR programs, or abandon this type of research. Each of these options diminishes the potential of CFR. There is little incentive for fishermen to cover the costs, since they either volunteer their time to CFR or are paid the equivalent (or less) of the money that they would make fishing.

The insurance challenges presented here are encountered in other forms of charter-based research that expose administrative bodies to liability. Examples include dive charters, live-aboards, and recreational fishing vessels. Although detailed discussion for each of these is beyond the scope of this paper, insurance challenges are not unique to CFR that engages commercial fishing partners.

Vessel Insurance – Strategies for Meeting the Challenge

Collaborative fisheries research is rooted in overcoming obstacles. Indeed, the essence of CFR is the pairing of complementary tools and skills to meet the technical challenges of collecting and processing information. Additionally, there are often significant social challenges associated with CFR due to the history of mistrust between fishermen and fishery scientists (Hartley and Robertson 2009), but the benefits of overcoming these social challenges are well documented (Conway and Pomeroy 2006). It is sadly ironic that, even when formidable social and technical barriers are overcome, the high cost of vessel insurance can hinder CFR as a progressive form of marine stewardship. Overcoming this barrier through insurance cost minimization can be pursued on a per-case basis, but lasting solutions are likely to require broader institutional changes. In addition to such reform, we evaluated ten practical strategies for minimizing insurance costs for individual CFR programs (Table 4). The relative strengths and weaknesses of these strategies are discussed below.

Strategy I – Commercial Partners With Pre-existing H&M Coverage

A powerful strategy for limiting insurance costs is partnership with fishermen whose boats carry preexisting H&M coverage. The average cost of H&M alone in this study accounted for 72.1% of the average total cost of policies with $1 million P&I + H&M (Table 2, Figure 1). This approach is practical because vessels that are desirable research platforms often carry H&M coverage. Preexisting H&M coverage also streamlines acquisition of P&I since the latter is easily added to H&M policies. This approach might not be viable in situations where vessels with preexisting H&M are unavailable, and it may discourage participation if an H&M policy is too expensive or difficult to obtain; a $5 million P&I requirement would make insurance difficult to afford under most circumstances (Figure 3).

Table 4. Strategies for minimizing the cost burden (defined as the total fraction of budget consumed by insurance) of insuring multiple vessels, and each strategy's relative: (1) power to reduce cost burden; (2) practicality of implementation (i.e., the logistical viability of each strategy); and, (3) support for social and scientific benefits of collaboration (cost burden; see, for example, Figure 2). Categories are: unknown [?], none [0], weak[+], moderate[+ +], strong[+ + +]. Strategies evaluated by *CALobster*.

Strategy (detailed in text)	Power to reduce cost burden	Practicality of implementation	Support scientific / social benefits of collaboration
I. Commercial partners with H&M coverage	++ / +++	+++	+++
II. Single commercial vessel with multiple fishermen	++ / +++	+++	++ / +++
III. Single commercial vessel and operator	++ / +++	++	++
IV. Scientific vessel run by industry-trained scientist	+++	0 / +	0 / +
V. Fishermen work on research vessel	0 / +	0 / +	0 / +
VI. *A priori* full P&I for CFR participation	+++	? / ++	? / ++
VII. Large projects reduce relative insurance cost	+++	+++ (large projects) + (small projects)	+++ (large projects) + (small projects)
VIII. Larger research awards to fund insurance	+++	? / +	+++
IX. Bulk rate discount for multiple policies	+ / 0	0	+++
X. Cost sharing	+	++	+++
XI. Institutional change	+++	0 / +	+++

Strategies II and III - Insuring Single (or few) Vessels and Hiring Additional Fishermen

Perhaps the most obvious (and common) cost reduction mechanism is insuring single (or few) vessels, although this has logistical consequences (Table 3, Table 4). A CFR program can work from single or multiple vessels, but the appropriate number depends upon program budget, objectives, and logistical needs. For example, a short-term project can be conducted from a single vessel. In contrast, multiple vessels may be preferable for long-term programs where dependence upon a single vessel is not realistic (Table 3). Similarly, if a project area is large and encompasses fishing grounds unfamiliar to the primary vessel operator, researchers can charter additional vessels that are operated by fishermen who are familiar with the area (scenarios 2 or 3 in Table 1). The charter of additional vessels, however, bears a cost burden that CFR programs may wish to avoid. The inherent trade-off is that reliance upon a single operator and vessel often poses problems that can be solved by chartering additional vessel(s) or hiring additional fishermen (Table 3).

When a CFR program can afford to insure only a single vessel, a subset of the resulting limitations can be mitigated through short-term participation of additional fishermen (Table 3). Those fishermen are hired to work a limited number of days as crew or consultants on the primary vessel. This approach provides the rationale for scenarios modeled in this study (Figure 3), and is sensible even when insurance is affordable (i.e., it does not exceed our recommended $10K limit; Figure 2) because overall cost savings can be applied to other expenses. A secondary benefit is the safety and efficiency of working from a familiar platform. It is important to note that most P&I policies do not cover a second non-crewmember, although such coverage can be purchased. To avoid violation of policy terms, the additional fisherman is paid by the operator of the primary vessel and the research grant is billed for that amount by the primary vessel owner. For single-vessel projects this approach is highly beneficial, and can be helpful even in situations where additional insurance can be afforded.

Strategy IV – Industry Training and Use of a Scientific Vessel for Sampling

An alternative to hiring additional vessels or fishermen is training researchers to use fishing gear as sampling devices. We employed this strategy in our spiny lobster CFR program from 2006-2009. Fishermen trained a UC biologist (Kay) to deploy and recover lobster traps from a modified vessel owned by UC. Use of a UC vessel allowed savings (Figure 3) due to the internalization of insurance costs as well as a lower per-day operating cost of ~$800. These savings are accompanied by the benefits of a more flexible at-sea schedule in which researchers need not be accompanied by fishermen on every trip. Fishermen accept the validity of the data collected because they provide the initial training as well as frequent oversight in the field when both parties fish or sample in the same area. Scheduling conflicts typically arise when fishing opportunities must be pursued due to market forces (i.e., it is much more profitable to catch fish than to conduct research), or when sea conditions are limiting and there simply are too few workable days to conduct research and fish commercially.

The drawbacks of basing a CFR program upon the use of a university vessel should be carefully considered. These drawbacks include reduced effectiveness and efficiency because university staff are less experienced than commercial fishermen; the fact that commercial boats are likely to be superior fishing platforms; compromised safety due to inexperience; less money allocated to fishermen; and, reduction of the social benefits associated with working closely with fishermen at sea. This strategy is likely to fail in many contexts, and only unique circumstances in our program permitted us to implement this strategy. Specifically, the biologist operating the UC vessel was experienced operating boats at the Channel Islands and was aware of local hazards. The biologist also maintained a working relationship with fishermen on the fishing grounds, and received frequent oversight regarding area-specific hazards, weather and fishing conditions, and he had crewed on a commercial lobster vessel with a senior member of the fishery as part of his training.

Strategy V – Fishermen Work on Research Vessel

An apparent compromise to insuring fishing vessels (Strategies I - III) or training scientific staff to conduct sampling (Strategy IV) is hiring fishermen to work on vessels owned by the research entity. This strategy has significant limitations and drawbacks: the research entity must bear the cost of owning, maintaining, and/or modifying a vessel, which could be less cost-effective than insuring a commercial vessel; separating the commercial fisherman from his or her vessel reduces efficiency; the social benefits of engaging a fishing community are likely to be diminished, or appear to be diminished in the eyes of fishery stakeholders, due to reduced interaction within fishing communities; and, at our university fishermen must be hired as a UC employees because the UC general liability self-insurance policy does not cover non-UC employees. Consequently, this stipulation imposes bureaucratic delays for the program and caps fishermen compensation at UC pay schedules that are well below what fishermen earn while fishing. For these reasons (and as with Strategy IV), this strategy may be appropriate only under special circumstances.

Strategy VI – A Priori Requirement of Complete Coverage for CFR Participation

A strategy that eliminates insurance burdens from research awards is the requirement that participant vessels provide proof of $1 million P&I insurance prior to joining a CFR program. Effectively, the cost is shifted from the CFR program and placed solely on the fishery partners. An example is found in the PSMFC online request for proposals (PSMFC 2009). Although the PSMFC is a thriving and well-respected collaborative entity, one limitation of this approach might be that some fishermen are unable to bear the initial cost and so there is a risk of disengaging potential partners. It is difficult to assess if, and the rate at which, this strategy excludes potential partners because PSMFC is unlikely to interact with vessel operators that do not meet the insurance requirement and, therefore, do not apply for funding or contact the CFR coordinator.

The effectiveness of the PSMFC's *a priori* insurance requirement is probably due to their emphasis working with fishermen that operate large vessels such as trawlers, seiners, and recreational commercial passenger fishing vessels (CPFV). These vessels are likely to carry P&I insurance because they are more expensive to purchase and operate, have larger crews or carry passengers (CPFV), and have greater risk exposure in normal fishing operations when compared to vessels with which we partner. Our experience building a CFR program *de novo* suggests that this approach could be challenging for newly developing programs, or small scale dive or trap fisheries. Indeed, artisanal scale fisheries are less likely to carry $1 million P&I than are large trawlers, seiners, or CPFVs, and when building a new grass-roots program it may be stifling to discourage potential participants with *a priori* insurance requirements. We reiterate, however, that the PSMFC is an important and successful collaborative entity that is viewed favorably by commercial fishermen with whom we interact. Thus, the merits of this approach warrant mention - especially for large scale CFR operations. Furthermore, it may be possible to engage potential partners with non-liability bearing activities such as port sampling or dockside interviews. Such interaction could lead to insurance investment once a relationship is established.

Strategies VII and VIII– Emphasize Large Projects and Large Research Awards Such That Insurance is a Small Fraction of Research Costs.

When research programs are large in scale or run for multiple years, the high income potential for fishermen might justify the cost of insurance. A CFR program that might fit this description is the NOAA Fisheries groundfish observer program. A simplistic strategy for funding multiple vessels, as well as other expenses, is to pursue only large research awards. This may be unrealistic for most CFR programs, especially those working at smaller scales.

Strategy IX – Bulk Rate Discounts

Bulk rate discounts have a limited ability to reduce insurance costs (Table 4). Bulk rates require participation of a large number of vessels (at least 6 required for bulk rate), and the per-policy savings realized from a bulk package is typically only 10-20% of the cost for an individual policy.

Strategy X – Cost Sharing

Dividing total insurance costs between or among collaborators reduces the financial burden to any single partner, but total programmatic costs are not reduced. Therefore, this strategy may have limited appeal. Sharing costs may make sense, however, since insurance policies are issued on an annual basis but research projects are often much shorter in duration. Cost sharing is one way to bridge this mismatch in scale. An incentive for fishermen to participate in cost sharing is the opportunity to enjoy the policy benefits for the remainder of the term, while remaining prepared and competitive for other CFR opportunities.

Strategy XI - Institutional Change

Per-case strategies for cost minimization are effective, but most have considerable drawbacks that will hamper CFR until insurance issues are resolved at institutional levels. In today's litigious environment, the rules that govern risk management are understandably rigid. Our experience suggests, however, that these research systems can evolve. For example, in 2006 we formally objected to a UC policy that forbade use of UC-administered funds for purchasing insurance on behalf of vendors (i.e., fisherman). Initially, we were assured that this policy was permanent and non-negotiable. Nevertheless, our local university administrators supported our objection in communications with University of California Office of the President and, by early 2008, a formal exception to this policy was in place for vessel insurance. In this case, an ostensibly intractable problem was overcome.

Another institutional change that benefitted our CFR program was the permission we received from UC to charter vessels carrying $1 million P&I coverage. Although such policies are expensive, and were not held by any of our commercial fishing partners, the $5 million P&I requirement from which we were exempted would have massively impacted our research budget (Figure 3) and slowed or halted the development of our program due to such a high initial capital investment. The institutional-level actions taken were directly intended to support our CFR program, and they are an indication of the larger institutional change that is both necessary and possible as CFR gains broader application.

The internalization of insurance costs when a UC vessel was used hints at a possible motivation for future institutional change. Specifically, if benefits to UC (i.e., grant money administered on campus) as a result of internalizing insurance expenses for commercial partners were to outweigh the costs, it is conceivable that the university might consider adopting the external source on some form of internal liability policy. As CFR gains momentum and becomes more common, UC and other administrative entities might consider the point at which it is profitable to internalize certain collaborative costs and form important, and potentially lucrative, research partnerships rather than lose research awards to competing administrative entities. The feasibility of such a scenario is uncertain, but this type of institutional change warrants exploration when mutual benefits can be identified.

In conversations among active CFR programs, a frequent theme that arises is the desire for insurance policies that cover individual researchers and/or research programs rather than individual (or multiple) vessels. The feasibility of such policies is summarily rejected by insurance representatives. CFR participants are left to wonder what level of market force or political pressure might cause the industry to reconsider.

SUMMARY

Recent actions by California lawmakers, resource managers, fishing communities, and marine scientists indicate that CFR is increasingly popular and important to advancements in fisheries management. The cost of vessel insurance can impede CFR in California and other states. The relatively high cost of vessel insurance must be resolved, especially for programs that depend upon multiple vessels. This challenge will be exacerbated if P&I requirements increase from the current norm of $1 million. Practical measures for minimizing costs include collaboration with fishermen whose vessels have preexisting H&M coverage, and/or hiring multiple fishermen to work on a single (or relatively few) commercial vessels instead of insuring many vessels. Insuring multiple vessels, however, provides greater program stability, increases transparency and buy-in from stakeholders, and maximizes benefits to individual fishermen. Long term solutions to this challenge probably hinge upon institutional reform. We have witnessed institutional change at our university that suggests such reform is possible on a broader scale, although change within the insurance industry seems unlikely for the time being.

ACKNOWLEDGMENTS

This project was supported by California Ocean Protection Council / California Coastal Conservancy research award 07-021 to M. Kay and H. Lenihan, and a grant from the University of California Office of the President – Coastal Environmental Quality Initiative to H. Lenihan, P. Dayton, and C. Costello. The authors thank C. Loarie, C. Blackburn, L. Cobb, T. Hartley, S. and S. Shrout, V. Massie, J. McKnight, and two anonymous reviewers for their input.

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Received: 29 October 2009
Accepted: 8 March 2010
Associate Editor: K. Hashagen