



Crustacean marking with coded wire tags – a simple solution to a difficult problem

Application Note APC09

The value of an effective crustacean tag

Tagging or marking crustaceans to allow individual or batch identification is clearly of considerable potential value in field studies including stock assessments, growth studies, recruitment studies, dispersion and migration investigations, measurement of exploitation and monitoring the effectiveness of stock enhancement.

Limitation of conventional tags

Marks attached to the exoskeleton are lost at the next moult and are thus of little value in long-term investigations. Conventional tagging has generally therefore been attempted by anchoring the tag through the exoskeleton and into the musculature. While such tags have sometimes proved effective on large crustacea such as adult lobsters, in other situations they have been associated with problems including high mortality, failed moulting, excessive tag loss and attraction of predators. As well as making recovery of sufficient tagged animals a problem, such effects introduce an unquantifiable bias into investigations that can render any observations invalid. Further, depending upon fisherman to report tags introduces another potential bias as they will frequently fail to do so due to overlooking the tag, not bothering to report it, or refusing to report it.

The coded wire tag.

General description

Use of the coded wire tag (cwt) overcomes most of the problems described above. The tag is a small length of stainless steel wire (1.0 mm x 0.25 mm) which is magnetised and injected into the animal. It is either batch or individually coded with a series of numbers etched along its length. Several studies on crustacea have indicated virtually no impact upon growth and survival, and the tag is reliably retained through moults. Very small individuals may be tagged and retention rates are very high – 100% in some experiments. Tagged animals are identified using NMT magnetic detectors, either manually or in processing lines, and the sampling protocol can be designed to be statistically robust. The tag code is read under a low power microscope.

Tagging the animals

The tags are cut, magnetised and injected using a NMT injector system. The Mk IV is an automatic machine powered by mains electricity or by a 12/24 volt supply. Depending on the species, up to 1200 animals per hour can be tagged, though it is likely that lower rates (perhaps 500-600 per hour) would be more realistic for most crustacea. Where tagging is carried out on board a ship then several tagging lines can be used to optimise vessel deployment and costs. For smaller projects or where tagging effort is more diffuse, the NMT multishot injector is the ideal tool. This is a hand-held device which avoids the requirement for a power supply. A single-shot syringe injector using pre-cut tags offers a low-cost option for tag retention and feasibility trials.

Detecting and recovering tags.

Where limited numbers of animals are involved tagged individuals can be identified using wand detectors, effectively checking animals one at a time. Depending upon the species, size and situation it should be possible to scan more than a thousand animals per hour.

For scanning larger numbers, especially of smaller animals such as shrimps, the use of a tunnel detector is likely to be advantageous. Various sizes are available; the smallest, the R8000, has tunnel dimensions of 200 mm x 100 mm through which the animals are passed. This can be undertaken by gravity feed or by a conveyor belt, or even within a pipe, and tens of tonnes of animals per hour can be scanned. A tag passing through the detector generates a signal that can allow recovery by hand or by incorporating an automatic diverter gate.

Although it is almost inconceivable that eating an animal with a tag inside would cause harm to humans, some workers prefer to avoid tagging an edible portion if possible. This also offers the opportunity of recovering tags from processing waste. Although some information (e.g. fishing vessel identity and exact location of capture) may be lost by such an approach it may be possible to calculate the size of the animal from the recovered material.

In summary, the approach to tag recovery will be heavily dependent upon the scale and design of the project. NMT will be very pleased to advise on an individual basis. We have a wide practical experience of advising on, and involvement with, many large-scale deployments of cwwt ranging from hundreds to millions of animals.

Some successful applications

Details of a number of successful applications of coded wire tags in crustacea are provided in Appendix I. The species involved are:

Caribbean spiny lobster	<i>Panulirus argus</i>
European lobster	<i>Homarus gammarus</i>
American lobster	<i>Homarus americanus</i>
Snow crab	<i>Chionoecetes opilio</i>
Blue crab	<i>Callinectes sapidus</i>
Mud crab	<i>Scylla paramamosain</i>
Dublin Bay prawn	<i>Nephrops norvegicus</i>
Red swamp crayfish	<i>Procambarus clarkii</i>
Spot prawn	<i>Pandalus platycerus</i>
Kuruma prawn	<i>Penaeus japonicus</i>
Common shrimp	<i>Crangon crangon</i>

Lobsters as small as 8 mm carapace length, crabs of less than 15 mm carapace width, and shrimps as small as 35 mm total length have been successfully marked. In virtually all cases where controls have been used there has been no significant impact upon survival, growth or moult frequency. In addition to investigations dedicated to evaluating the technique, cwt have been successfully used in crustacean stock assessments and for

evaluation of stock enhancement. In a lobster stock enhancement project tags were still being recovered nine years after the animals had been released.

Developing proposals for cwt projects

Northwest Marine Technology will be pleased to help develop proposals for projects involving deployment of our tagging techniques.

Typically, following initial exchange of information, NMT will draft a brief report suggesting an overall approach and details of tagging and tag recovery operations. The customer will then comment on this to arrive at a final version. We find this interactive process very valuable in ensuring that we have taken account of all relevant constraints and opportunities, and that the customer is fully appraised of the potential for the tagging system.

It is stressed that this service is offered entirely without obligation, and that we are pleased to provide an early-stage input to even tentative proposals.

The customer is free to use the whole report or extracts therefrom, with or without acknowledgement, in any way he feels will be helpful to further the proposal.

For an example of the type of document we produce see “Potential for use of coded wire tags for fishery investigations of common shrimp, *Crangon crangon*.”

For further information please contact Dr David Solomon.

APPENDIX I. Some successful crustacean applications of coded wire tags.

Lobsters (*Homarus gammarus* and *H. americanus*)

A major stock enhancement project in the UK was evaluated using cwt (Wickens et al 1986; Anon 1996). Between 1983 and 1988, over 91,000 juvenile European lobsters were reared to a size of 12-15 mm carapace length, taking about three months from hatching in warmed water. They were then tagged with a cwt in the base of the 5th walking leg using a MkIV automatic injector with a modified positioning jig. The animals were released at four different sites around the UK. Between 1988 and 1994 lobsters from local commercial landings were checked for the presence of cwt, and over 1400 were recovered. The time between release and recapture ranged from 3 years to 9 years. Recorded recapture rates ranged from 1% to 5% of the numbers released, varying between sites and years.

Anon (1996) stated

“These are the first results to provide quantitative evidence that juvenile lobsters released into the wild on lobster habitat can survive to legal size in substantial numbers, enter baited pots set by commercial lobstermen, and contribute to commercial catches and the breeding stock.”

In addition to contributing to assessment of the overall survival and contribution of the reared lobsters, the monitoring programme based on cwt allowed a full economic evaluation to be conducted and provided important information about dispersion from stocking site and release strategy.

Uglem and Grimsen (1998) reported experiments tagging European lobsters down to 8 mm carapace length and found that a different tag orientation to that used by Wickens et al (loc.cit.) gave a higher retention rate, between 94% and 99% in the smaller animals. Only the group of smallest animals showed a higher mortality than controls; however when this size group were marked with half-length (0.5 mm) tags the mortality was again similar to that of the controls.

Krouse and Nutting (1990) explored placing the cwt in the prodopus of the walking legs of *H. americanus*. This site was chosen as tag recovery could be effected by excision of the distal part of the appropriate leg without affecting the market value of the lobster. The size at tagging was 12-24 mm carapace length. Tagged and untagged lobsters showed similar growth increments, frequency of moults, and survival. Retention rates were lower than those for tags in the base of the legs; retention rates through the first moult averaged 68.1%, through the second 83%, and 92.3% through the third after tagging.

Cowan (1999) used Krouse and Nutting's technique with sequentially CWT to individually mark 5,533 wild juvenile *H. americanus* in Maine. A total of 434 (8%) were recaptured at least once contributing to an assessment of growth, annual yield and recruitment. Some individuals were recaptured up to four times, being retagged and released each time.

Caribbean spiny lobster (*Panulirus argus*)

Sharp et al (2000) tagged individual spiny lobsters in the lab to test the method, placing the tag in the ventral abdominal muscle at the second somite. They were “first stage” (mean carapace length 6.1mm) and “second stage” (CL 6.2mm). Tag retention in the second stage individuals was very high (96%) as was survival (97%). Both tag retention (86%) and survival (74%) were a little lower in first stage animals. Most tag loss occurred at

the first moult. Field experiments were then undertaken; in the words of the authors “Data obtained from these recaptured lobsters provide the first detailed estimates of growth of *P. argus* under natural conditions during the earliest part of their benthic life and illustrate the potential usefulness of coded microwire tags in mark-recapture investigations of this and other species.”

Snow crab (*Chionoecetes opilio*)

Bailey and Dufour (1987) used cwt on crabs of 75-110 mm carapace width, using different legs for tag placement to indicate one of six size classes at time of tagging. A total of 4967 crabs were captured, tagged and released. Commercial landings were then monitored, and a total of 109,534 crabs were checked for the presence of tags; 83 were recovered. This provided a population estimate of 5.7 million, with 95% C.L. of about 25% of the estimate. Estimated rate of exploitation within the season was 22%. To check for tag loss, 235 of the released crabs were double tagged with cwt and with highly visible vinyl tubing tied around the cephalothorax. Of 28 crabs recovered with the vinyl mark only one appeared to have lost its cwt.

Blue crab (*Callinectes sapidus*)

A laboratory evaluation by van Montfrans et al (1986) with small blue crabs (18.2 to 27.6 mm carapace width) indicated high retention rates for cwt injected into the basal muscle of the fifth pereopod. Retention in crabs that had moulted at least once was 88%, and retention through the second moult was 100%. No significant differences in growth or survival were noted between tagged crabs and controls. In the 12% of crabs that lost their tags at the first moult, it was observed that the tag had penetrated a part of the endoskeleton that was shed during moulting. It was concluded that these individuals had been improperly oriented during the tagging process, and that the recorded retention rate could be improved upon.

Fitz and Weigert (1991) also conducted laboratory studies on cwt retention in blue crabs. The size range used was 29-67 mm carapace width. Double-length (2.1 mm) cwt were injected into the same location as in the van Montfrans *et al* study described above. Retention through the first moult was 98.2%, and 100% through the second to fourth moults. No differences in growth, survival or behaviour were apparent between tagged and control animals. Fitz and Wiegert (1992) then used coded wire tags to undertake studies on a blue crab population in a salt-marsh estuary.

Mud crab (*Scylla paramamosain*)

Le Vay et al (1998, 1999) evaluated the cwt as a mark for assessing stock enhancement of mud crabs. The tags were injected into the coxal muscle of the fourth pereopod, centrally positioned in the muscle cavity under the thoracic sternite. Animals as small as 13.5 mm carapace width were successfully tagged without any effect on growth rate or moult frequency, but there was “a possible indication” that mortality was increased in crabs of less than 25 mm c.w. Tag loss rates varied between batches from 0 to 8%. Implanted tags could be removed after several months with most crabs surviving in marketable condition.

Dublin Bay prawn (*Nephrops norvegicus*)

Hillis (1985) reported on some preliminary trials with cwt in *Nephrops*. Tags were injected into the basal joint of a claw or walking leg, according to the 1 mm size class, so that the growth of recaptured individuals could be established. A total of 957 animals were tagged and released in July 1984. One month later 23 tagged animals (2.4% of those tagged) were recovered from a catch of 18,800 animals of the appropriate size range. An additional 1492 animals were tagged and released at this time. However, scanning a catch of 12,000 a year later failed to produce any tagged individuals. It is not possible to say to what extent this lack of tagged animals may have been due to tag loss, mortality or dispersion. No tag retention trials were reported.

Red swamp crayfish (*Procambarus clarkii*)

Isely and Eversole (1998) undertook an investigation of retention, growth and survival of cwt on small (20-41 mm total length) freshwater crayfish in tanks. The tags were injected transversely into the ventral surface of the first or second abdominal segment to lie in the musculature just beneath the abdominal sternum. The tags were visible in this location and could be removed with only minor trauma to the animal. Tag retention after 200 days was 100%. No significant differences on mortality or growth were noted between tagged and control animals. Individual moults were not recorded but the animals increased in length threefold during the experiment and attained sexual maturity.

Spot prawn (*Pandalus platyeros*)

West and Chew (1968) obtained high retention through several moults with cwt injected into the abdominal musculature.

Prentice and Rensel (1977) also used cwt on spot shrimp but selected a site in the animal that was not used for human consumption, the thoracic sinus. The animals ranged from 15.0 to 22.5 mm carapace length. Average retention rate was 95% over 180 days during which time all animals moulted at least twice. Most of the tag loss that was observed occurred during the first moult in animals tagged before a modified needle was used to reduce the tendency for tags to be drawn partly through the carapace when the needle was withdrawn; thus better retention should be achievable. Mortality was similar in tagged and control animals. In subsequent tests shrimps as small as 10mm carapace length were tagged.

Common Brown Shrimp (*Crangon crangon*).

Following an expression of interest from a potential customer, NMT undertook some preliminary trials using cwt in small brown shrimps. Tags were injected into the uropod of shrimps as small as 35 mm in length, and retention rate was 100% after one month; no information was gathered regarding moults or growth rates. A tagging rate of about 360 per hour was achieved using a MkIV injector, but there is no doubt that this could be increased to well over 500 per hour with properly designed facilities and experience.

Kuruma prawn (*Penaeus japonicus*)

A project is currently under way in Japan with small (average 40 mm length) shrimps (*Penaeus japonicus*). The tags are placed in the abdominal musculature, and tagging rates of 231 to 1203 per hour were achieved by different operators using Mk IV injectors. Highest retention rates were achieved by an operator working at 800 per hour. A total of over 280,000 shrimps was marked in thirteen days in July-August 1995. After 7 days in captivity the shrimps were released near the mouth of Matsuom City Bay. Samples from the release site in the first five weeks of sampling contained 49.3%, 37.7%, 40.0%, 54.0% and 47.8% tagged individuals. Two samples from nearby areas contained 12.5% and 21.4% tagged individuals.

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